THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
Alas!	133
The Metropolitan Railway Contracts	134
The Disposal of Refuse in the Twentieth Century	135
A Meter for Alternating Currents (*illustrated*)	136
Electric Fire Risks	137
Naval Electric Cables (*illustrated*)	138
The Rating of Factories	138
The Accumulator as a Source of Economy in Electric Traction	140
The Scientific Use of the Induction Coil with the X Ray Tube	142
Power Gas and Large Gas Engines (*illustrated*)	143
Correspondence	145
Legal	146
London County Council	147
Fatality on the Central London	147
Our Legal Query Column	148
Business Notes	148
Southport Electricity Works and Tramways (*illustrated*)	153
Supply Station Accounts	162
City Notes	163
Traffic Receipts	164
Stocks and Shares	164
Share List of Electrical Companies	165
Market Quotations	166
Duties on Electrical Goods for the Colonies	167
Institution of Electrical Engineers:— Capacity in Alternate Current Working (*illustrated*)	168
Institution of Electrical Engineers (Glasgow Section):— Discussion on Mr. Yorke's paper (*illustrated*)	170
Liquid Fuel	172
Prosecution of an Electric Light Company	173
The Municipal Electrical Engineer's View of the Paris Exhibition	173
Electric Tramway Enterprise	174
New Patents	175
Abstracts of Published Specifications	176

THE

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ALAS!

IT is not often that we, the editors of a journal devoted to the interests of electrical science, throw open our leading column to matters which have no apparent relation to electricity, but we should fail in our duty to the Royal family, to our readers, and to the public generally if we omitted to refer to the topic which has occupied the minds of everyone throughout this unhappy week. Even as we write, the solemn tolling of a mournful bell adds a vague sense of fear and desolation to the profound sorrow which we feel at the death of Her Majesty Queen Victoria. That sense of fear is inspired by the apprehension lest with her death a long period of prosperity in these happy isles may have been brought to a close; it may be that many happy and prosperous years are still to come—but who amongst us can speak from actual experience of the momentous results which may follow the death of an English Sovereign? The Royal Prerogative which has not been exercised for over a hundred years, and which, for the last 63 years, has lain dormant but within reach of one of the best rulers that this country has ever known, may once more see the light; and the voice of history loudly proclaims that the demise of a Crowned Head not infrequently brings disaster in its wake. Truly, we venture forth into the Unknown. May that Unknown be soon disclosed to us at least as a reflection of, if not as an improvement upon, the past!

The reign of the gracious lady who has just departed this life is fraught with peculiar interest to all who make the study and practical application of electricity the first object of their lives. Under her beneficent rule the science of electricity has developed in a manner which finds no parallel in the history of the development of kindred subjects. Fostered by Queen Victoria's beneficent rule and patronage, the wondrous powers of electricity have been transformed from the plaything to the slave of mankind.

In 1837 the immortal achievement of George Stephenson had taken firm root in the minds of those who saw the advantage of a cheap and expeditious means of locomotion. The same year ushered in the Electric Telegraph. The fetters which then bound the giant Steam had already been unloosened, to the end that the prosperity of the British Empire both on land and sea might thereafter be maintained. So in 1901, at the dawn of a new century, when life has just departed from the most respected and the most beloved of Englishwomen, the giant Electricity, as a means of transmitting energy from place to place, and as a cheaper and more rapid means of transit, has been pressed into the exacting service of mankind. Are these inopportune reflections at this most solemn moment?

Turn to the columns of every paper—remove the cover of every periodical, and you will find the same story. The soldiers of every industry, the lovers of every art, and the professors of every science, are bearing their tribute to the kindly interest, the fostering care, and the unwavering affection which the great Queen Mother has shown towards their welfare throughout the course of her long reign; and if, in adding our humble tribute to her memory, we have used language which is unfitting, our excuse must be that we can scarcely find words full enough to adequately express our deeper feelings.

THE METROPOLITAN RAILWAY CONTRACT.

A few weeks ago we drew attention to the vast importance of the decision of the Metropolitan Railway Companies, now in suspense, on the system of electric traction to be adopted upon their lines. The conditions upon which tenders were invited were, as our readers know, of the most open and indefinite character; practically, the proposition placed before the competitors consisted simply in the question:—"At what price, and in what manner, are you prepared to undertake the substitution of electric for steam traction on the Inner Circle?"

That an immense amount of labour, both mental and physical, was entailed to the engineering staffs of the various firms which entered into the competition, is manifest, and we cannot doubt but that much benefit will result therefrom, especially if the authors of the respective schemes can be prevailed upon to publish at least the main features of their proposals; the intimate acquaintance thus obtained with the problems which present themselves, in the preparation of a comprehensive scheme of such magnitude and importance, and the evolution of new and original methods of solving them, form an educational exercise of the most valuable and fruitful nature, only excelled, in fact, by the experience gained in actually carrying out such projects. Whatever the outcome of the deliberations of the engineers who have the matter in hand, one thing is certain to result—a great step will be made in the direction of the general adoption of electric traction on railways, "a consummation devoutly to be wished."

Unfortunately, however, as might be expected, one result of the want of definition has been that the tenders exhibit very wide divergences from their mean value; this was partly due, we suppose, to excessive caution in the case of the higher quotations, and a desire to get the contract, even at cost price, on the part of the lower tenderers, combined with a plentiful lack of data on which to found an accurate estimate of the probable cost of carrying out the structural work in the tunnels. The cost of the electrical equipment for a given service can be readily estimated with a sufficient degree of accuracy; but the work involved in the necessary alterations to the track, a very important item, is of a character most difficult to deal with on paper.

Then, again, it is a not uncommon practice to treat the tenders in such a case as this as merely first approximations, and to issue new and more detailed specifications, based upon a thorough analysis of the respective schemes, for the purpose of obtaining new tenders on a common basis, which can be fairly compared with one another. Those firms who anticipated this mode of procedure would, of course, "play for safety," sending in quotations which they were morally certain would cover the cost of the work with a wide margin, and expecting to bring down their price to a closer approximation in the final competition. Whether this practice will ultimately be adopted by the Metropolitan Companies or not, remains to be seen. Perhaps they will seize the opportunity of taking an absurdly low tender while they have the chance; but we would far rather see them pursue the opposite course, which would, we believe, be conducive to greater satisfaction in the long run to all parties concerned.

Recently Sir W. H. Preece and Mr. Parker have been, we believe, in Buda-Pesth, inspecting the experimental apparatus erected by Messrs. Ganz & Co. to demonstrate their system. As is set forth more fully elsewhere in this issue, Messrs. Ganz use the three-phase system, generating and distributing at 20,000 volts, and feeding the overhead trolley wires at 3,000 volts. If this system is proved to be satisfactory for use on the Metropolitan Railways, in spite of the short stages and frequent stops, the rapid acceleration essential to an efficient service, and the necessity of economy of energy, then it cannot be doubted that an immense step in advance has been made—one of the greatest jumps ever made in electrical engineering. We have often urged that the adoption of some such system is absolutely essential to the successful application of electricity to main lines of railway; but we are by no means confident that it is preferable to the direct current system for the case under consideration.

Besides the engineering question, however, there is another, and, unfortunately, a very weighty feature to be borne in mind—that is, the financial aspect of the matter. The railway companies, as is well known, are already loaded with an excessive capital, and are not in a good position to obtain loans on the most favourable terms. Consequently the financing of such a costly undertaking as the electrical equipment of the Inner Circle is a most important factor in the problem; it is even possible, much as we regret the fact, that this consideration may outweigh all others.

In this respect British firms are at a grave disadvantage as compared with their American and German competitors. In the United States finance and industrialism are closely linked; a big financial group, headed by well-known millionaires, controls practically the whole of the electrical manufacturing industry, and is ready to provide ample funds for the carrying out of projects of the first magnitude. Similarly, the German system, in which an electrical manufacturing company is almost invariably associated with one or more of the leading banks and an auxiliary so-called industrial bank, or company for the promotion of electrical enterprises, enables the leading firms to undertake huge schemes under the most favourable conditions, with the results set forth in a recent article in our columns.

In Britain, on the other hand, no such organisation exists. While almost any scheme which holds forth prospects of fabulous profits in an attractive form is eagerly subscribed to by the public, it is an almost impossible task to obtain the necessary capital to carry out sound industrial projects which merely offer a safe investment with moderate dividends.

Protection abroad and conservatism at home have borne their share in limiting the field of British electrical enterprise; but, after all, due credit must be given to our unique municipal system, which, at least, has offered to British manufacturers a fair field, in which financial jugglery is of no avail whatever. As things are, we can no longer say that our manufacturing firms are blind to the immense possibilities of the electrical industry; several British firms are now ready and able to equip the Inner Circle as cheaply and as well as any firm whatever, but they are handicapped by the lack of capital.

We greatly fear that, despite all other considerations, the contract will be awarded, not to the firm whose scheme is best adapted to the circumstances, but to the one that offers the most favourable financial deal. May our forebodings prove to be unfounded!

THE DISPOSAL OF REFUSE IN THE TWENTIETH CENTURY.

By G. WATSON, A.M.I.C.E., M.I.M.E.

It may be safely predicted that in the century just commenced the reduction of the death rate in towns by means of sanitary improvements will occupy the attention of municipal authorities even more than in the past.

The recent demonstration made on the Campagna at Rome that malaria is communicated to human beings by mosquitoes may have an important indirect bearing on the subject of town refuse. It has been clearly proved by two heroic officials of the British Government that malarial poison is gathered up from swamps by mosquitoes and by them carried in all directions; and further, that men who exclude these insects from all contact with their bodies, from sun-down to sun-rise (when these pests are active), may live in regions hitherto supposed to be deadly, in perfect health. It is not unreasonable to suppose that poisons may be carried from decomposing refuse heaps by flies and other insects, and that the danger of such deposits may consist not only in lowered vitality from living in the impure atmosphere they create, but that also they may become the actual cause of blood poisoning in the manner indicated. Accumulations of refuse also become nurseries of rats, the disseminators of the bubonic plague. It is not unsafe to assert that the New Century will not tolerate refuse deposits anywhere near inhabited dwellings. It may be further prophesied that it will not for long tolerate the use of refuse for burning bricks in clamps in the neighbourhood of London. No traveller on the main lines that radiate from the metropolis can fail to observe the sickening stenches that proceed from these brick fields. They are, perhaps, most noticeable on the Great Western Railway from London to Maidenhead, where it is necessary to keep the carriage windows shut practically all the way if these stenches are to be kept out. A refuse destructor properly designed and constructed is at present the only known means of disposal which satisfies both sanitary and economical requirements. Like most other improvements, it has been a long time on the way, but certainly the years from 1875, when such furnaces first began to be used, to the present time, have not been wasted. They can now be made to work with perfect satisfaction in crowded neighbourhoods, completely surrounded by dwelling houses, and they can be adapted for use on a large scale in big towns and cities, or on a small scale for villages, hospitals, and even hotels. They satisfy sanitary requirements by reducing town refuse to a hard innocuous clinker, with a proportion of ashes, without emitting from the chimney shaft any nuisance in the shape of stink, smoke, or dust. The stink and smoke are cured by maintaining the temperature within the furnaces themselves at from 1,500° to 2,000° F. The fine dust which used to be distributed from the chimneys of destructors working under strong natural draught, was frequently mistaken for smoke, and there can be no doubt that it caused considerable nuisance. The early efforts to reduce it generally took the form of the provision of flues slightly enlarged, and provided with baffle walls, upon which the dust was supposed to strike, and so settle on the bottom of the flue. More logical designs were based upon the principle of making the flues very large, so that the velocity of the gases might be insufficient to carry the dust along, which was thus supposed to be deposited on the bottom of the flues. This arrangement was, of course, fatal to any chance of properly utilising the heat of combustion, owing to the expansion and cooling of the gases in these huge flues.

The stinks which were undoubtedly caused by the working of early destructors were due mainly to the use of natural draught, which drew such huge quantities of cold air through the furnaces every time they were either charged or clinkered as to keep them constantly at a low temperature. The stinks were to a great extent destroyed by means of Mr. Jones's "fume cremator," whenever that appliance was worked regularly with an abundance of fuel. This fume cremator consisted of a grate, with suitable rings of fire-brick above it, placed in the main flue between the furnaces and the boilers—when there were any. The cost of working was, however, so high that in most cases the cremator was only worked intermittently, or allowed to go entirely out of use, so that the full benefit of it was seldom realised. The only types of destructor which may be said to prevail at the present time are designed to work at a high temperature under artificial draught, forced either by means of steam jets or fans, and in the furnaces with which the author is particularly connected, the further precaution is taken that all the gases arising from the refuse drying, when it is first put into the furnaces, have to pass over the hottest part of the fire before they can escape to the chimney, while the products of combustion of all the furnaces in a battery are well mixed in a moderate-sized main flue (in which the brickwork is constantly at a glowing red heat) before they are passed into contact with the heating surfaces of the boilers.

To catch the dust the author has devised a large circular swirling chamber, in which the dust is separated by centrifugal force, in much the same way as cream is separated from milk in a centrifugal cream separator. Thus the escape of fine dust from the chimney is prevented. Destructors now satisfy economical conditions by the saving of cartage, the saving of labour, and the full use of the residuals. As regards the saving of cartage, this is effected by placing the destructors in the centre of the population area, and this course is now fearlessly advocated in all cases. The size of installation to be adopted depends, of course, largely upon the manner upon which the heat is to be utilised, as well upon the question of cartage; but it is noteworthy that the City of Hamburg is now destroying half of its refuse, amounting to about 250 tons a day, in the largest destructor in the world, consisting of 36 cells in one house. No doubt such a complete concentration involves extra cartage, but it saves expense in management and contributes to efficiency.

Saving of labour is probably the most important question in connection with destructors at the present time. The amount of labour required at different destructors varies in a most astonishing way. It is certain, however, that it ought not to exceed 7d. for every cubic yard of refuse destroyed in any district in the United Kingdom, and that, where it does exceed that figure, something is wrong. Seeing that, unfortunately, the cost of burning is usually stated in tons, irrespective of the number of cubic yards that go to a ton, and also of the percentage of moisture contained, it may be well to state that the refuse of London measures about 2 cubic yards to the ton, whereas in the North of England the muck does not exceed 1½ cubic yards to the ton.

The Strand Board of Works (now incorporated in the City of Westminster) has recently installed a large destructor in which the refuse is tipped directly out of the collecting carts into the furnaces. The results of this arrangement have yet to be fully ascertained, but it is hoped that some pence per ton will be saved in the cost of feeding the furnaces, and a great sanitary improvement effected by making unnecessary the handling of the muck.

The use of the residuals is not less important than the saving of labour and cartage, and the twentieth century will utilise all its clinker for making mortar, concrete foot paths, fireproof floors of concrete, concrete bricks and tiles. It will use all the fine dust caught in the dust-catchers as a basis for disinfecting powder, and all the ashes from the ashpits for plastering work. It will pass all its soldered cans through special furnaces in order to recover the solder, and to clean the thin steel plate from its coating of tin, in order that it may be used as scrap steel in steel works, and also in certain chemical manufactures. Most important of all, it will utilise in full the heat made by the combustion of the refuse, for raising steam, to be converted into light and power.

In the case of large destructors for big towns the power will generally be utilised in combined power plants for electric lighting, electric tramways and electric power distribution; and in small villages the heat will be used to generate steam for driving stone breakers, chaff-cutters, fans for smiths' forges and other such tackle as is generally to be found in a town yard; and, in addition, for grinding mortar from the clinker, treating the clinker in breaking and sizing machinery for concrete purposes, and also in some cases for driving flag presses for making paving slabs, and brick machines for making bricks.

The Corporation of Bradford, the municipality of Hamburg and the Vestry of St. Luke's, London (now part of the metropolitan borough of Clerkenwell), have probably up to now made the greatest advance in the matter of utilising the clinker. In all three of these cases the whole of the clinker is utilised for the above-mentioned purposes. In the case of St. Luke's, very large orders for clinker have been received for the purpose of making concrete floors in warehouses. In Bradford a very brisk sale of mortar takes place, and also of broken and sized clinker for concrete purposes, and of ashes for plastering. Concrete paving slabs are also manufactured on a large scale. In Hamburg the clinker is used mainly for concrete purposes, and that it is appreciated is shown by the fact that no less than 125 tons of clinker are sold, or used by the town itself, per diem. It may be remarked that the refuse of Hamburg contains 50 per cent. of incombustible matter. When the author was at the works about the middle of December last, there was not a cart load of clinker remaining on the premises, and it was being fetched away as fast as it could be produced.

It may be objected that all this has little interest for readers of the ELECTRICAL REVIEW, but after all, the economical question is one which has most interest for all engineers who have to raise steam; and it may be interesting to central station engineers to show how they can to some extent level their load curves during the daytime by the use of such miscellaneous machinery, while at the same time turning their residual materials into money, instead of paying to have them carted away.

Another very important question bearing on the economical result is that of the life of the furnace. The bill for repairs and renewals of a destructor may easily mount up to a most disastrous figure unless it be constructed in the first instance with the most suitable materials, and with all the skill and care which experience alone can furnish. The capital outlay to satisfy such requirements is large, but not so large as that required to rebuild the furnaces at frequent intervals. The day of cheap destructors is past. They must now be constructed so that the furnaces can be worked day and night, with the minimum of interruption for repairs for at least five years. Some engineers are advocating stand-by plants, requiring double the space and double the capital outlay that ought to be necessary. Such expedients are quite needless, in the author's opinion, if the furnaces are built according to the best modern practice; but the question of the life of the furnace will always remain one of the very first importance.

The most important bye-product of the destructor—that is, the waste heat—yet remains to be discussed. Probably no question has been much more hotly debated than this. On the one hand, we have figures put forward by persons (of whom the author himself may be considered a type) too much interested to escape the suspicion of some people that he is too sanguine as to results. On the other hand, we have "cold water" poured in gallons by persons who are *not* sufficiently interested in the question to ascertain the facts. It may be mentioned with regret that some "cold water" has even been detected diluting the excellent stern common-sense with which the ELECTRICAL REVIEW has treated this question. This is not a subject which can be dealt with in general terms, and it would be just as unreasonable to say that, universally, you can obtain so many pounds of steam at a given pressure for so much refuse burned, as to say that you could get so many pounds of steam per pound of coal without stating whether the coal is "Best Welsh" or cheapest "Smudge." The fact is that town refuse varies far more in different towns than does coal in different collieries. It will, however, be safe to generalise to this extent, that in all districts in the neighbourhood of coalfields, from 1 lb. to 1¼ lbs. of steam may be counted upon as available for external use for every pound of refuse burned in an efficient destructor, and that in residential districts, remote from cheap coal, from ¾ lb. to 1 lb. of steam may be counted upon with equal certainty.

These generalisations are sufficiently correct for preliminary purposes, but it will be well for any engineer who has to give reports to study the question particularly upon the spot. The author knows of a seaside town which subsists upon summer visitors, where from the beginning of May to the end of September hardly a ton of coal is burned in domestic grates; gas fires being almost universal for cooking and warming. In the same town small gardens abound, and they contribute to the destructor an enormous quantity of vegetable refuse, which requires a lot of work to put it into the furnaces, and fills a lot of space when it gets there, contributing very little to the resultant heat. There are in the town in question very large numbers of combined privies and ashpits from which wet nightsoil, amounting to about 40 per cent. of the total refuse, is collected. It can, therefore, be readily imagined, that the working of the destructor in summer, to give complete satisfaction to all concerned, is no easy matter; without having any regard to steam-raising. In the winter, on the other hand, the refuse contains large quantities of cinders, the garden refuse is largely absent, and the results are proportionately better. In view of such instances as this, it seems hardly necessary to warn electrical engineers, and others, against any person who comes to them with a general guarantee of so many pounds of steam per pound of refuse, before the guarantor even knows in what district the apparatus is to be installed. It is a fact worthy of note that efficiency is generally in inverse proportion to the size of the guarantee. After making the necessary reservations, it may safely be prophesied that the twentieth century will see destructors and power plants combined in almost every instance, where the number of destructor cells exceed four. The destructor will cease to be regarded as an undesirable neighbour or a poor relation, and will be looked upon in its true light as a means of improving the balance-sheet of the power plant. In support of this readers may be referred to what has been accomplished in the way of steam raising at Oldham, Shoreditch, Darwen, Hereford, Bradford, Norwich, Fulham and Beckenham, and many other towns where up-to-date combined plants are either in course of construction or commencing to work with the most promising results. The period of doubt and exaggeration, of controversy and failure, of absurd guarantees and poor performances, is passed; and refuse destructors have now entered the period of sober, useful performance. No one desires more than the author that the results should be recorded with strict accuracy and published with despatch and regularity, as fully and as fairly as the accounts of the electric light undertakings throughout the country. When this is done the twentieth century will be in a position to know what is the lowest cost at which it can be rid of its town refuse, after allowing fully for the value of the residual products, of which steam-power will prove to be by far the most important.

A METER FOR ALTERNATING CURRENTS.

A METER for recording watt-hours in alternating current lighting circuits, characterised by great simplicity of construction and cheapness, has recently been introduced by the Allgemeine Elektricitäts Gesellschaft, of Berlin. It is alleged that by the introduction of this invention the meter rent paid by consumers will be reduced to one-half its present amount.

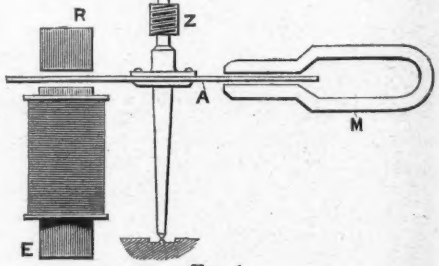


FIG. 1.

The meter consists of a revolving disc, A, which is sub-

jected to the action of two alternating magnetic fields differing in phase, which, owing to their special arrangement, impress a comparatively large driving force on the disc. The

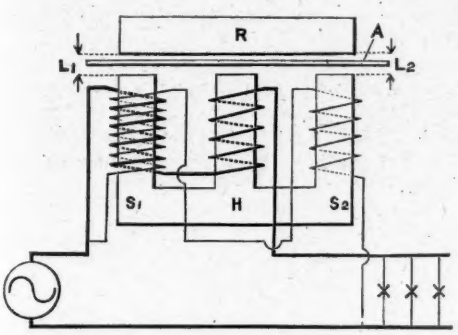


Fig. 2.

magnetic circuit is closed. The pressure bobbins, S_1 S_2, as well as the main current bobbin, H, are placed at one side of the disc, the three cores of the bobbins being connected to a single yoke, E (fig. 1), and the magnetic circuit completed by a single armature, R.

The operation of the meter is as follows :—The two shunt bobbins, S_1 S_2, impart alone (without the main current) a fairly strong turning moment to the disc, either when the

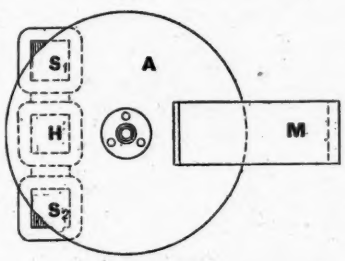


Fig. 3.

air spaces, L_1 L_2, of the two pressure cores are unequal, or when the magnetic force of the two pressure bobbins is different.

This turning moment would cause the meter to run when no current was flowing, and it must be reduced to an amount which is just sufficient to overcome the friction of the apparatus. This can be done by varying the number of turns or the air space ; in the actual instrument the latter is made adjustable. If the main current is now turned on, a mutual action takes place between the magnetic field of the main current and the vortex currents generated in the disc by the shunt bobbins on the one hand, and between the magnetic fields of the shunt bobbins and the vortex currents generated by the main current bobbin on the other hand. The result is that the disc, A, is set in rotation.

The field of the main current bobbin acts upon the fields of the shunt bobbins so as to reduce one and increase the other, as shown in fig. 4. The core of one of these bobbins

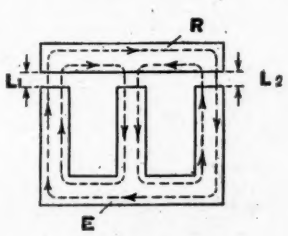


Fig. 4.

would thus reach saturation point much sooner than that of the other, and the proportionality would be disturbed. To prevent this, a part of the main current circuit is wound about one of the shunt cores, as shown in fig. 2, to compensate for this inequality in the field. If the same effect were produced by winding different numbers of turns on the two shunt bobbins, then, as stated above, the meter would run when the main current was not turned on, which is an insuperable objection to this method of compensation.

The speed of rotation imparted to the disc in this way is directly proportional to the product of the current and the pressure. The apparatus, therefore, counts the number of

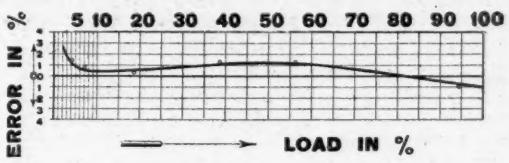
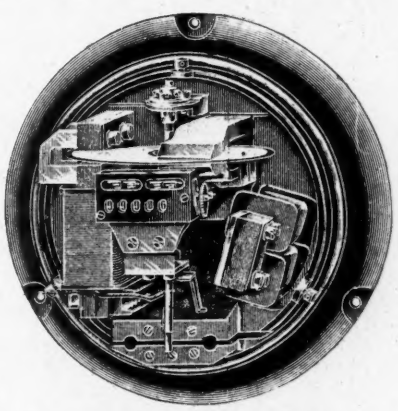


Fig. 5.

watt-hours. The magnet, M, acts as a brake to the disc. The rotations of the disc are transmitted to a counting mechanism, in the simplest way, by worm gear. The reading of the meter is in kilowatt-hours, and is shown in a single row of figures on the face of the counting mechanism, so that the consumer can at any



Front View of A.C. Watt-hour Meter.

moment, without trouble, read off the number of units which he has consumed, *i.e.*, how much he owes to the electric supply company. No reduction of the reading is necessary, since the instrument is constructed so that the constant is always unity. The instrument, if properly set up, retains its original accuracy for any length of time. The percentage of error over the whole range of the instrument is shown by the curve, fig. 5. It is evidently of some advantage to the consumer to work at full load.

ELECTRIC FIRE RISKS.

Under the above title there appears an article in *Cassier's Magazine* which is chiefly distinguished for the coining of a new word—"fool proof." There is certainly something about this expression which reminds one of Swinburne's "foolometer," but as the article in question proceeds from the pen of one Hubert S. Wynkoop, we are constrained to conclude that it is but another instance of the famous saying "Les beaux esprits se rencontrent."

Mr. Wynkoop refers to the danger that arises from unfamiliarity, and suggests—very wisely—that electric wiring should be more carefully controlled by municipal or other authorities. He points out that everyone knows that the filling or the overturning of an oil lamp may start a fire, sometimes preceded by an explosion, similarly that it is a matter of common knowledge that blowing out a gas jet by way of extinguishing the flame conduces to asphyxiation, and that searching for a leak of gas with a lighted candle may have an elevating tendency upon the surroundings. There-

fore, he ingeniously adds, people refrain from experimenting on these lines, but, owing to the complete ignorance of the general public upon things electrical, most outrageous things are done with the utmost sincerity in connection with electric lighting.

With this latter observation we can agree from personal experience. A recent incident of this kind is worth recording. A certain worthy photographer who does everything in connection with his business electrically that it is possible to arrange for, brews his tea by a chemical equation and so forth, has a bell push hanging over his bed within easy reach, which communicates with the kitchen, and is in the habit of ringing for his matutinal tea by pressing the switch in the orthodox manner. He recently left town for a few days, and in his absence the housekeeper, in sweeping out his room with more zeal than discretion, severed the connection between the aforesaid push and the bell lead by sweeping away three or four feet of the wire. In the anguish of her soul the housekeeper called in a "friend" who knew all about electricity, and he, without the least hesitation, connected the pear switch to the lighting circuit.

On the photographer's return he found the pear switch hanging invitingly over his bed as usual, and on the following morning he pressed the switch as usual; but the result was not quite as usual, and after the fire engines had been paid off the photographer sat down and wrote a fearful letter to the electric light contractors, threatening them with dire pains and penalties. In the end the cause was discovered, and the photographer retired to a back seat to ruminate upon the extraordinary difference between electricity when it rings a bell and when it produces light.

We have never ceased to urge the great value of competent supervision of the wiring of houses for electric light, and the real urgency of legislation for placing electric wiring contractors under some such restrictive conditions as plumbers. If everyone who aspired to become an electric light contractor and undertook the wiring of houses had to deposit a substantial sum and take out a license, which would become forfeitable upon any serious scamping being discovered in his work, such a course would prove a considerable deterrent to jerry wiring, and would thus, in a measure, safeguard the public against such technical quacks as the one above alluded to (we don't mean the photographer).

Under existing conditions the wiring of houses for electric light is rapidly degenerating into something that is given away with the sale of fittings, and this tendency, unless checked, will prove to be a serious obstacle to the due development of domestic electric lighting.

NAVAL ELECTRIC CABLES.

All cables in the Navy are supplied in thousand yard lengths, and are kept coiled up on large wooden drums or reels, of such diameter as to ensure no unfair strain being put upon the insulation while the cables remain coiled up and stowed away.

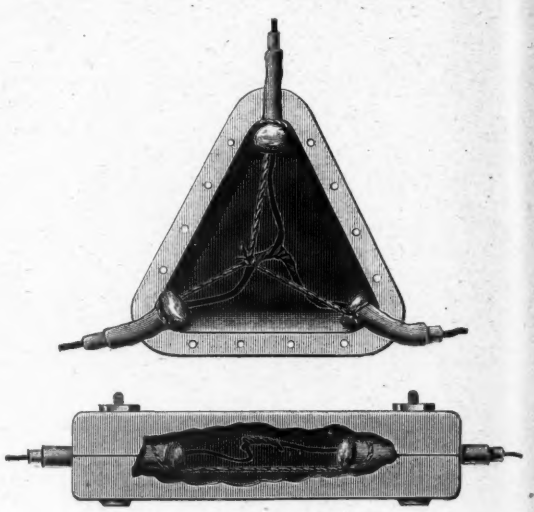
These drums can be conveniently landed in boats, and rolled along when ashore, so as to lay the cable as they go.

Speed and simplicity are the great considerations in Naval defences, and thus the cable is left above ground and exposed, as a rule, instead of being buried. In most cases, the work is only of a temporary nature, such as would be required in the case of a ship going into port for repairs, to guard against an attack while she is at anchor, and possibly in a disabled condition.

Cables for mining purposes are generally of three different kinds, chiefly distinguished by the number of their cores.

The most generally used is the single-core cable whose core consists of 36 wires; it has a resistance of about 6 ohms altogether, and is insulated with Hooper's patent insulation, an armouring of steel wire forming a return as well as a protection for the insulation. Where this cable is used for submarine work the return, of course, takes place through the sea water as well as through the armouring, but whereas the earth return is in itself reckoned as offering a resistance of 3 ohms with the usual earthplate of sheet copper, that of the armouring is only calculated as two.

The four and seven-core cables are very similar, but offer a slightly smaller resistance, about 5·6 ohms for the 1,000 yards. Each core is insulated very carefully, so that with a battery of 500 volts the insulation resistance per 1,000 yards should be at least 2,000 megohms after the cable has been 24 hours under water. A certain proportion of sulphur is used to preserve the india-rubber coating next to the core, but the amount is very small, and where the rubber comes in contact with the metal it is practically pure; by this means a very good result is obtained, combining durability with the maximum insulation. These cables are used for mining work where a line of mines is run across a ship channel to guard the entrance. Watertight connecting boxes are used to join the ends of cables together; they are made in two halves, with corresponding recesses cut to receive the cable



Connecting Boxes.

ends, which, when screwed together, grip the cable very tightly. This would not of itself be sufficient to entirely prevent the ends drawing, though the insulation is formed into a "pudding" inside the box of considerably larger circumference than the cable itself; there must be no possibility of any strain coming upon the actual junction of the cores, so the two cables are united by a strand shorter than the junction itself, which will take any strain that might otherwise come upon the core. For branch leads to the mines a different kind of connecting box is used which consists of two triangular recessed plates, the main cable passing through the recesses at the base angles, while the branch entering at the apex is forked into it; here again, the precaution is taken of uniting the three puddings formed by the insulation where the core has been bared with strands, so that no strain shall come on the core itself. So much for the mining cables; the next in order is the searchlight cable, which is used for running searchlights at a distance either in a boat or ashore. This has a core of 37 wires, offering a resistance throughout its entire length, 1,000 yards, of only ·36 of an ohm. Its insulation is necessarily somewhat better than that for the mining cables, in consequence of the comparatively large current used, and offers a resistance of some 3,000 megohms.

Shore and submarine telegraph cable is sometimes supplied, in which case it consists of, in the former, three cores of 27 L.S.G., with a resistance of 36 ohms, and in the latter, seven cores of 24 L.S.G., giving 9·4 ohms resistance. The insulation in the latter is of about 2,000 megohms resistance.

THE RATING OF FACTORIES.

While it is at all times a difficult matter to provide for the equitable rating of property for the relief of the poor, the question becomes particularly intricate when the assessment committee, or the valuer in their employment is called upon to estimate the ratable value of a factory or engineering works.

With a view to explaining the cause of this evil, it is necessary to refer to certain Acts of Parliament. By a statute passed in the reign of Elizabeth (43 Eliz., c. 2, Sec. 1), machinery was made ratable as personal property, and it was no answer to an assessment under that Act to say that the machinery in question was annexed to the freehold. This statute was repealed in the letter, but as we shall presently see, re-enacted in substance by later statutes. An Act which was passed in the year 1836, provided (by Sec. 1) that no rate shall be allowed which shall not be made upon an estimate of the net annual value of the several hereditaments rated thereunto; that is to say:—"Of the rent at which the same might reasonably be expected to let from year to year, free of all usual tenant's rates and taxes and tithe commutation rent charge, if any, and deducting therefrom the probable average annual cost of the repairs, insurance, and other expenses, if any, necessary to maintain them in a state to command such rent."

This section refers only to hereditaments. Personal property (including machinery) were impliedly, if not expressly, put out of rating by the Poor Rate Exemption Act, 1840 (3 and 4 Vict. c. 89, Sec. 1), which enacted that "it shall not be lawful for the overseers of any parish . . . to tax any inhabitant thereof, as such inhabitant, in respect of his ability derived from the profits of stock in trade or any other property." Taking this in connection with Sec. 1 of the Parochial Assessment Act, 1836, which only contemplates the rating of corporeal hereditaments, it now appears that when it is sought to rate a person in respect of machinery, the question *ought to be* whether he is an occupier of lands and whether the machinery in question is part of the land. If machinery is *not* part of the land, it should be out of rating. If it has become part of the land by annexation, *i.e.*, by being fastened to the land, its value should be taken into consideration.

Such would appear to be the common sense interpretation of these statutes, but the Courts have decided otherwise. From certain decisions (to be considered later) it transpires that the question which the valuer has to ask himself, when determining the ratable value of a mill is: "At what rent would this mill be reasonably expected to let from year to year as *a going concern?*" To arrive at this figure, the value of machinery, plant, and fixtures must be taken into consideration. The result is that even after the statutable deductions have been made, the occupier of the mill is called upon to pay rates far in excess of those which he would be compelled to pay in respect of premises of equal magnitude which contained no valuable machinery.

At first sight the assessment of a factory as a going concern may appear to be equitable enough. The freehold is being used for the purpose of earning a large income, and it is not unjust that a certain proportion of that income should be diverted for public improvements or the relief of the poor.

As modified and expanded by various cases which have come before the Courts, the application of the principle in practice has very little to commend it. Take the case of an occupier of a valuable mill, which, owing to depression in trade or the baneful influence of labour disputes, cannot be worked at a profit or at all. Decided cases go far enough to enable us to affirm that even under these conditions a rate based upon an enhanced value must still be paid. The existence of such an anomaly fully explains the hostile attitude which manufacturers generally adopt towards the indirect rating of machinery.

In a rate laid upon buildings, to which machinery is attached for the purpose of manufacture, the real property ought to be assessed according to its actual value as combined with the machinery, without considering whether the machinery is real or personal property, and liable or not to distress or seizure under a *fieri facias*, or whether it would go to the heir or executor, or, at the expiration of a lease, to the landlord or tenant (R. *v.* Guest (1838), 7 A. & E., 951; 7 L.J., M.C., 38). The principle above enunciated was adopted and confirmed in what is known as the "Tyne Boiler Case," which was decided in the Court of Appeal in 1886. A magic distinction was then drawn between machinery when regarded as personal property and machinery "fixed to the freehold," which enhances the value of the premises. The doctrine there laid down may be thus stated:—"In estimating the ratable value of [premises] used as a manufactory, machinery and plant placed thereon for the purpose of making them fit as premises for such a manufactory are to be taken into account as enhancing the value of the hereditatment, although such machinery and plant remain personal property, and are not physically attached to the premises. In course of his judgment in this case the late Lord Esher thus expressed himself:—"I believe the rule really to be that things which are on the premises to be rated, and which are there for the purpose of making, and which make the premises fit, as premises for the particular purpose for which they are used are to be taken into account in ascertaining the ratable value of such premises. . . . . It seems to me that when things are brought into that category, they would pass by a demise of the premises as such, as between landlord and tenant." Lord Justice Lindley concurred with this decision, but he limited the scope of his judgment by saying, "Nothing is included, so far as I understand the nature of machinery, which would be mere loose machinery, and which would not pass to a tenant to whom the works were demised." No answer can be found in these judgments to the important question, How is machinery, which is not itself ratable, to be valued as enhancing the ratable value of a hereditament? [Tyne Boiler Works Company *v.* Longbenton Overseers or Tynemouth Union (1886), 56 L.J., M.C. 8; 18 Q.B.D. 81.] The doctrine of the Tyne boiler case also applies to mines, for it has been decided that the lessee and occupier of a coal mine is ratable for the full annual value of the mine, though increased by improvements, such as the erection of engines made at his own expense. [1829 R. *v.* Granville, 4 M. and Ry., 171.]

The ratable value of a shipbuilding yard is also enhanced by the machinery used upon it where such machinery is essentially necessary to the shipbuilding business to which the premises are devoted; and this although some of the machinery may be capable of being removed without injury to itself or the freehold. [Laing *v.* Bishopwearmouth Overseers (1878) 47 L.J., M.C. 41.]

The Tyne boiler case practically decided that machinery is ratable whether fixed to the freehold or not. This point was made still clearer in Gifford *v.* Chard Union [63 L.T., 249]. Premises were used as a manufactory for the purpose of lace making, upon which certain boilers, engines, &c., were placed for carrying on the said manufactory. These machines were essential to the use of the premises as a lace factory. The machines were each of them distinct, and could easily be removed for sale or repairs. Some were fastened to the floors by screws, others were not fastened, their own weight being sufficient to keep them steady, but further than this the machines were no part of the soil or hereditaments. It was decided by a Divisional Court that although some of the machinery and plant was capable of being removed without injury to itself or to the freehold, and although it remained personal property, yet, being essentially necessary and permanently attached to the appellant's business, it was all rightly taken into account in estimating the ratable value of the premises as enhancing the value of the hereditament. That the Assessment Committee must disregard the question whether the mill or factory is in use or not at the time of making the rate appears clear from the following cases:—

In Staley *v.* Castleton Overseers [1864, 5 B. & S. 505; 10 L.T. 606] a cotton mill, owing to depression in the cotton trade, was no longer worked, but was maintained at some expense as a factory, with machinery in a fit state for working when the trade should revive. A question arose as to whether the occupiers under these circumstances were ratable to the relief of the poor. It was decided that the occupiers were ratable for the mill. The same principle applies although the owners of mill have ceased to use and have no intention of ever again using a mill. Thus in Harter *v.* Salford Overseers (6 B. & S. 591; 34 L.J., M.C. 206), the owner of a silk mill gave up his business, with the intention of never resuming it, and the mill had not since been worked, but, with the machinery and other articles and things in it had been advertised for sale. All the contents of the mill were essential articles and things for a tenant to have in working it for the manufacture of silk. The machinery, some of which was affixed to the floors and ceil-

ings, was in the nature of tenants' fixtures. A man occasionally went to the mill in order to protect the property against trespass or depredation. It was decided that the owner of the mill was ratable for it.

Moreover, the rent actually paid for premises at the time of the rate is not always taken as an absolute criterion, inasmuch as the rule that premises shall be rated upon the basis of the rent for which it might reasonably be expected to let from year to year, is applied with considerable strictness. Thus the ratable value is not always based upon the rent actually earned at the time of assessment. In one case three farms had been let at a certain sum annually. They might, however, reasonably have been expected to let, and might have been let at a larger sum. The overseers assessed the occupiers at the rent actually paid by them. It was decided that they should have adopted the larger sum, *i.e.*, the rent at which the farms might have been reasonably expected to let as the estimate of the net annual value. [Hayward *v.* Brinkworth Overseers, 1864, 10 L.T.N.S., 608.]

It has been decided that in estimating the probable rental of a concern, the profits of which vary in different years, the Assessment Committee must not point to a particularly good, nor must the owners point to a particularly bad, year for the purpose of arriving at the correct figure. This is upon the principle that in determining the rent for premises, a landlord and tenant would mutually include all risks in the rent upon which they decide. Thus in ascertaining the rent which a tenant could afford to pay, the possibility of strikes is one of the matters which he would be entitled to take into account, and, therefore, when the strike came he would not be entitled to a deduction. [Hoyle *v.* Oldham Union, 1894, 2 Q.B., 372.]

We are thus confronted with the fact that machinery is ratable. It remains to consider how the value of machinery is to be estimated for the purposes of rating. It is a general principle that the ratable value of machinery is based upon its value at the time of the rate, not upon what it once was, nor upon what it may hereafter become. [Met. Board of Works *v.* West Ham (1870), L.R., 6 Q.B., 193 at p. 198.]

The method by which an engineering works may be valued for assessment is as follows :—Assuming that the works have been valued and that rent is paid for them as a going concern, the net annual value may be ascertained by deducting from the gross rental the average annual cost of repairs, insurance, and other expenses necessary to keep the premises in the state to command the rent. In making a deduction for repairs, it is important to observe that the repairs for the particular year are not to be taken into account, as they might be below or above the average. The average amount in past years is to be ascertained. The Courts have generally allowed an imaginary fund to be built up year by year to reproduce the property when it is worn out, and this is particularly beneficial in the case of machinery which, even if it does not wear out, is certain to become obsolete, and therefore less able to command the rent.

The "gross rental" above referred to is frequently calculated upon what is known as the "contractors' theory of rent." Upon that theory it is assumed that the occupier has employed a contractor to build the factory and equip it in such a manner as to place it in the hands of his employer as a "going concern." Assuming for the moment that the contractor becomes the landlord and the occupier becomes the tenant for the time being, the rent which would be payable under such circumstances is the gross rental.

A simple example will illustrate the hardship which may accrue to the occupier from the wide construction which the Courts have put upon the statute of 1836 in allowing the value of machinery to enhance the rent at which it would have been reasonably supposed to let from year to year.

Suppose the proprietor of an empty mill or an ordinary house were to let it at an annual rental of £500 without making any stipulation as to the use to which his tenant should put it. Assume that the tenant hires machinery from an engineering firm for £500 a year. In due time the question must arise—What is the ratable value? The premises have been let at £500, and the landlord must be presumed to have demanded such a rent as was reasonable under the circumstances ; and if the statute in question be construed strictly, that is the only figure which can be looked to. As a matter of practice, however, the Assessment Committee, under the existing order of things, would in all probability add the rent of machinery to the rent of the mill and make an assessment on that basis.

The greatest difficulty arises, however, when the occupier of a manufactory fills the *rôle* both of landlord and tenant—*i.e.*, where he is a freeholder in possession. In such cases the amount of hypothetical rent whereby the value of the premises is "enhanced" is generally fixed at 5 per cent. of the initial cost of the machinery and its erection. Even when annual allowances are made for depreciation—unless, indeed, such allowances are very substantial—it is clear that this rough-and-ready mode of assessment may in some cases give rise to hardship, while in cases where the producing capacity of the mill becomes increased the ratable value may be greatly under-estimated. Thus there are certain classes of machinery or plant which, while their producing power may remain stationary, gradually become obsolete and wholly worthless. The most that can be said for the 5 per cent. method is that it is simple and easy of practical application.

THE ACCUMULATOR AS A SOURCE OF ECONOMY IN ELECTRIC TRACTION.

By W. H. BOOTH.

If the records of small tramways be examined, it will be found that although the steam pressure may be 150 lbs. and nominally high-class engines are employed, the consumption of coal per kilowatt-hour will range from 6 to 14 lbs. This is largely because of the very small ratio of average to maximum load upon the engines. First-class condensing steam engines with high pressure steam ought to produce 1 KW.-hour from each 2½ lbs. of fuel. This assumes a steady load. Obviously, then, anything that will enable a steady load to be secured is deserving of careful consideration. The accumulator or secondary battery alone offers any immediate prospect of securing such a load. The economy to be secured may be set down for a small system with a load factor of 25 per cent. as 7½ lbs. of coal saved per kilowatt-hour. A mean load of 75 amperes at 500 volts may be safely assumed. The maximum load will be 300 amperes, and the economical engine must be capable of running continuously at about 37·5 KW. As the maximum load is 150 KW., the excess over the mean load will be 112·5 KW., and this must be provided by the accumulator. The current output to be provided from the cells is therefore 225 amperes. To provide current at a voltage of 500 to 550 about 250 cells will be requisite. Such cells will cost, probably, £10 each fixed, the total cost of the battery being thus £2,500. Depreciation, interest and maintenance may be set down at 15 per cent., or £375 per annum. The loss of energy in passing through the accumulator cannot be assumed at less than, say, 20 per cent.

This loss applies in the case under review to three-fourths of the total current produced, the remaining fourth going direct from the engine to the line. The battery supply current must, therefore, be increased in the ratio $\frac{4}{3}$, and in place of being 0·75 of the whole requirement, will be 0·94. The total engine power must thus be 0·94 + 0·25 = 1·19 of the capacity first found; that is to say, in place of a mean output of 75 amperes the dynamo must furnish nearly 90 amperes. The fuel cost per unit furnished to the line is also to be increased from 2½ lbs. to 3 lbs. by reason of the loss in the battery.

With coal at 10s. per ton, the cost per year of 6,850 hours at 10 lbs. per kilowatt-hour works out to £573. By means of the accumulator we hope to save seven-tenths of this, or £401. To do this we are going to spend £375 annually upon our battery, and this leaves a net saving of £26. So far, good, but hardly sufficient *per se* to justify the outlay. But we are neglecting the reduced cost of engines and generators.

At least two sets will be required in any case. In the first case there are two sets of nominally 100 KW., costing, say, £20 per kilowatt, or £4,000 in all. In the case of accu-

mulators the engines are, on the same basis of power, to be provided of a nominal capacity of 30 KW. I use this small number of 30 in place of the apparent 45 KW., because the ordinary nominal 100-KW. set will do about 150 KW. economically, and the proportionate size of 30 KW. may be equally assumed to run economically at 45 KW., which is the average demand when accumulators are employed. The cost of two such sets at £20 per KW. is thus £1,200, and we have effected a saving of £2,800, which, at 5 per cent., represents £140 per annum. The total gain is thus increased to £166 per annum, an amount well worth saving.

The foregoing estimates are, of course, only approximate, and represent the saving with coal at 10s. per ton. The cost of plant is also approximate, in the absence at the moment of data and records. No change is assumed in the cost of boiler plant. If there is any change, it will be in the direction of reduced cost, and it is also probable that the saving in engine room accommodation more than covers the housing of the battery. Finally, the capital outlay on the battery of £2,500 is less than the saving on the engines and generators.

The ordinary constant overall loss on a 100-KW. set is about 16 KW. at full load. In place of large sets, we are now enabled to use small ones of 30 KW., on which the constant loss will be $\frac{3}{10}$ths of 16 KW., or 4·8 KW. Reduced to terms of fuel, this now represents 14·4 lbs. per hour, or 43 tons per year, a further economy of £21 10s. So far, then, a capital economy of not less than £300 has been effected with an annual economy of nearly £190. The subject will bear numerous estimates being made upon it. Thus there is the possibility of all night running of the engine, which can be arranged to reduce still further the size of the steam plant and generators, and it is open to question whether the size of accumulator I have assumed—costing £2,500—is not considerably in excess of what is necessary. Such a battery would be rated at 250 amperes discharge rate with a capacity of 750 ampere-hours. The maximum rate of discharge of 225 amperes that would be demanded from it would never endure for long at a time, but in case of breakdown to the steam plant a large capacity would prove useful, and, after all, too close an economy is not desirable in accumulator design, especially where their function is to equalise load—to absorb and give out energy like a fly-wheel.

In the foregoing estimate the battery has been assumed to act simply as an equaliser—to plane down the innumerable peaks of the load curve to a uniform level.

An examination of an autograph record strip from the main station ammeter will show that such a battery will never be discharged more than a fraction of its charge. A tramway works fully 18 hours per day. If an engine of 30 KW. capacity is necessary for this, then if the engine hours be now made 24 per day, its power might be reduced to 22½ KW., and during the working day of 18 hours the battery might be allowed to discharge 25 per cent. of its capacity, this being recharged in the idle hours of the night. If fully charged, the battery would have a capacity of 75 amperes for 10 hours, and should it seem desirable, an engine of about 60 KW. capacity might be run for about 13 hours daily to supply current and recharge the accumulator.

The foregoing argument is, of course, based on data that may be questioned. That the coal consumption of average tramways is from 7 lbs. to 14 lbs. per KW.-hour is, unfortunately, true, and the reason for this extraordinary wastefulness is partly because there is not sufficient care to utilise the well known aids to economy, such as "economiser" or flue-feed heaters, or to employ condensing plant, and, having got it, to keep it up to the high water-mark of performance—that is to show above 26 inches vacuum; but principally because in the very nature of things, the load is of so widely variable a nature that engines much too large must be employed, and an underloaded steam engine is invariably most wasteful and extravagant. Station design must also be debited with much uselessly burned fuel. It is not possible for a fireman to properly attend to fires unless there is an ample space between the boiler front and the wall behind. It is poor economy to cut down the firing floor in order to save a few feet of light roofing.

Whether an accumulator will deal with its charge for 20 per cent. is, of course, a proposition that will be challenged. Ten per cent. is claimed by some makers, but probably further knowledge is requisite before this point can be decided more certainly. On it and upon the cost of maintenance will depend the success of accumulator traction. But there can be no two opinions as to the large field ready to be occupied by accumulators as soon as their merits are established or believed in.

In order best to carry out a system with a battery, it appears that the engine should be of such power as to perform the mean duty required. It is thus necessary to know what the mean load will be and what ratio it will bear to the total load. The mean load will be determined by the number of cars at work and their average speed, and will not vary much from 10 to 12 amperes per car for 28-feet cars in ordinary English practice. I have previously suggested an empirical formula for determining the ratio of mean and maximum load, which is sufficiently close for all ordinary cases, and has been proved correct, or nearly so, by nearly 200 test cases. There is a means whereby sufficient energy may, perhaps, be stored to level down the load curve of a tramway load without so much loss as the possible 20 per cent. of the accumulator. This means is the fly-wheel of special construction running upon friction bearings. It is only by some such contrivance as this that fly-wheels of special weight could be run at all economically. On ordinary bearings their frictional losses would render them, probably, more wasteful than accumulators. An inspection of an autographic diagram will show just what could be accomplished in this way. Experience points to the probability that the system would be unsuitable for very small systems of three or four cars as well as for large systems, but it might be applicable to ordinary small systems. On the whole, however, the accumulator at present holds out the better prospect of success.

The system has been already considerably applied in Germany, and batteries have shown themselves able to save over 50 per cent. of fuel in less unfavourable steam conditions than some that exist in England, while they have also shown two or three years of endurance without signs of failure. American practice also has tended to the use of batteries. There can be little doubt that they are essentials to economy in the case of small systems which cannot hope for a good load factor. It is also certain that if the economy of compound engines is to be secured, this can only be done by providing a full and steady load. It may be laid down fairly approximately that the economy of an engine depends upon its load factor, being inversely as this factor for ordinary cases in practice, when the engine is just about equal to the maximum load. Without accumulators it is very doubtful if any economy can be shown by a compound engine over a well designed simple engine, that is, a simple engine just big enough to turn at normal speed when under its maximum load, which maximum turning effort will be about double that of a compound engine of equal size referred to the low pressure cylinder, and therefore more likely to be wasteful. Accumulators, in fact, enable economical engines to be used under economical conditions.

It may, of course, be objected that there are certain difficulties to be overcome in satisfactorily arranging a battery and a dynamo to work together in parallel, the engine always working to its regular load, and the battery merely equalising. One method is that of fixing the engine cut off at the economical point by means of a particular form of governor, that shall, however, be able to effect earlier cut-off if a given speed be exceeded, as might be the case should the circuit be broken. It has been suggested that the shunt-wound generator should be employed when working with equalising accumulators, but this is a subject to which electricians may with advantage devote themselves. Evidently what is required is some means whereby at loads below the average, the potential of the generator current shall exceed that of the battery, while above that output the potential of the machine must fall, and allow the accumulator to discharge into the line.

Since writing the foregoing the benefit of some German experience has been available. Accumulators appear to have met with considerable success in Germany, and it is found sufficient if the battery be of such size as to provide the maximum discharge for one hour. Thus, if the

maximum current be 300 amperes, as in the case under consideration, the battery capacity would be provided to yield a steady 300 amperes for 1 hour. On this basis the cells would probably cost not more than £6 each, so that the total cost would not exceed £1,500 in place of £2,500. Correcting the figures of economy already found, the total capital economy will now be £1,300, and the annual saving will be £240.

Several systems of battery arrangement are employed. Apart from the question of wages, the best system would probably be that which places the accumulator at the opposite end or towards the opposite end from the power house—a position that would require a separate charging set. But the most economical system, on the whole, is, perhaps, that known as the buffer system, the battery being run in parallel with the generator. The generator cannot be of compound type. It must be shunt wound with falling characteristic, the E.M.F. of the generator and of the battery crossing each other at about the mean station output, so that below that output the engine will feed the accumulator, and above that point will permit the battery to discharge to the line. Such a system favours an engine with a fixed rate of expansion and a considerable speed variation, this variation being utilised to vary the potential, and the system being thus to a considerable extent self-regulating. While this subject was entered upon by the writer entirely from the point of economy of steam, his inquiries thus far have led him to believe that for small tramway systems the economy will be undoubted if suitable and liberal batteries are provided, but that larger systems do not require batteries, because where load factors of 70 and 80 per cent. can be secured the battery losses must more than outweigh the economy. At the same time, with large load factors it must not be overlooked that the output of the battery will be comparatively small, that quite a small battery will be competent to rub off the spikes of the load diagram, and that the point where a battery ceases to be useful will thus be extended further up the scale of load factors than might at first be thought reasonable.

THE SCIENTIFIC USE OF THE INDUCTION COIL WITH THE X RAY TUBE.

Perhaps no electro-magnetic apparatus is so extensively used and so imperfectly understood as the induction coil. The transformer for alternating currents has been thoroughly investigated theoretically, and electrical engineers can design without difficulty the transformer which is best suited for any given conditions. The induction coil, however, is made to fixed patterns which have been experimentally evolved by the leading makers chiefly with the object of giving the longest possible spark. When a new application of the induction coil, such as the exciting of X ray tubes, makes its appearance, the old coils are persistently used without any attempt to discover whether their design is the best under the new conditions.

A paper by Dr. B. Walter, of Hamburg, in the *Fortschritte auf dem Gebiete der Röntgenstrahlen*, Vol. iv., p. 1, explains some highly advantageous alterations in the design of induction coils when used for the generation of Röntgen rays, especially when the coils are worked with the Wehnelt break.

It is well known that X ray tubes in a longer or shorter time become useless through the increase of the vacuum to such an extent that a discharge can no longer be forced through them. This, according to Walter, is due to the projection of particles of platinum on to the glass wall of the tube from the anti-cathode, and nothing favours this injurious process so much as the passage of the electric discharge through the tube in the wrong direction. It becomes, therefore, of the utmost importance for the durability of the tubes that the discharge from the coil shall be unidirectional. To secure this result, the tension induced in the secondary coil by the "make" of the primary must always be kept lower than the tension required to send a discharge through the tube.

When the E.M.F. used to work the coil is very high, as is the case with very rapid breaks, such as the Wehnelt, the slope of the rising current in the primary may be as steep as the slope of the falling current after the "break." The tension in the secondary being proportional to the steepness of this slope, the "make" spark under these conditions will be equal in length to the "break" spark. A coil working under these conditions would be fatal to the longevity of X ray tubes.

This evil is best remedied by increasing the self-induction of the primary circuit either by increasing the number of turns round the core or by increasing the diameter of the core. Walter has designed a primary coil of variable self-induction by winding on the core four separate coils or layers of insulated wire, the ends of the coils being connected to terminals on a switchboard by which the layers can be arranged in series, in series parallel, or in parallel. He thus obtains three degrees of self-induction by varying the number of effective turns on the core. Primary coils with different diameters of iron cores may also be used.

The smallest self-induction should be such that the spark length with a Wehnelt break should be from 25—30 cm.—a tension which is sufficient for the hardest tubes used to illuminate the chest. The dimensions of cores suitable for coils of various (maximum) spark lengths are given in the following table :—

Spark length of the coil in cm. ..	30	40	50	60	70
Length of the iron core in cm.	60	75	90	105	120
Diameter of the iron core in mm.	50	55	60	65	70
No. of turns in one layer on core	150	200	250	300	350

With these dimensions, the spark from any of the coils specified will, with the Wehnelt break, not exceed the safe limit of 30 cm. When the self-induction is increased by switching in double the number of effective turns, the spark length is reduced to one-half ; and by the third arrangement it is reduced to one-fourth. Each separate layer of wire in the primary must cover at least two-thirds of the length of the core, to secure uniform magnetisation.

In trying a tube for the first time, the primary coil is arranged with maximum self-induction. If the tube is found to be too hard for the coil thus arranged, the self-induction of the primary is gradually reduced till the tube is excited.

The use of a primary coil of variable self-induction has an additional advantage ; the consumption of current is the smallest possible for the output of the coil. This is especially important with the Wehnelt break which is very wasteful of current. With the Wehnelt break, the length of the anode pencil must be reduced, in proportion as the self-induction of the primary is increased, so that it is advisable to have the Wehnelt cell fitted with a number of anode pencils of lengths corresponding to the different degrees of self-induction, anyone of which pencils can be switched into circuit as required.

The best proportion for the acid solution is 23 parts of acid in 100 parts of water, since it is best to have the resistance as low as possible, so that the apparatus can be worked with the lowest possible E.M.F. It has been assumed in the foregoing remarks that a public supply of direct current at 65—110 volts is available. For most experiments, except the instantaneous illumination of the human chest, a battery of 20 accumulators, capable of giving 15 amperes, will suffice. When the E.M.F. of the supply is 220 volts, it should not be used direct, but reduced by placing suitable resistances in shunt and series with the primary coil. Where alternating current supply only is available, a rotary transformer to deliver direct current of 10 to 15 amperes at 40 to 50 volts should be used. For instantaneous chest exposures, a current of 25 to 30 amperes at 65 volts will be required.

The primary, with variable self-induction, may also be used with advantage with the ordinary mercury break. When the speed of this break is very great, the maximum spark length of the coil will be reduced, unless the self-induction of the primary is at the same time reduced. Any reduction of the self-induction must, in this case, be accompanied by a corresponding increase in the capacity of the

condenser, with the view of preventing leakage at the break, and also to keep the frequency of the oscillations in the primary circuit constant.

The turbine break of the Allgemeine Elektricitäts Gesellschaft gives 70—80 breaks per second; and the output of a coil with this break is enormously increased by reducing the self-induction of the primary coil and increasing the capacity of the condenser; the output, indeed, approaches very close to that obtained with the Wehnelt.

For ordinary working, where a great output is not necessary, it is best in the interests of economy of current and of tubes to use the largest amount of self-induction in the primary coil. Walter's apparatus is manufactured by the firm R. Seifert & Co.

POWER GAS AND LARGE GAS ENGINES.

On Friday, December 14th, 1900, at a meeting of the Institution of Mechanical Engineers, Mr. Herbert A. Humphrey read a very interesting paper on "Power Gas and large Gas Engines for Central Stations."

Introducing the subject by suggesting that the design of central power stations of large output will, during the next few years, be of great interest to mechanical engineers, he points out that England is undoubtedly behind American and Continental practice. Attention was drawn to three power stations of 70,000 H.P. in course of construction in New York; and to the London Stations at Bankside of 20,000 H.P., at Deptford, 10,000 H.P., and at Willesden, 7,000 H.P., as well as to the 100,000 H.P. station being erected at Manchester.

Mr. Humphrey said that the sale of electricity in Great Britain is now over 100 million units per annum, being three times what it was four years previously. It is more than probable that this rate of increase will be exceeded in the future, so that the importance of the highest ability being applied to obtain the most economical and efficient power plants will be apparent.

The capital expended in electricity supply undertakings already exceeds £16,000,000 sterling, and the capital outlay for electric traction is even greater; yet at this moment the number of miles of electric tramways under construction in Great Britain is fully equal to the miles of route already in operation.

Last year 89 provisional orders for electric lighting were granted. Electric railway and tramway Bills and tramway Provisional Orders, numbering 46, received Royal Assent; also applications were received for 21 light railways to be worked by electricity.

The advantage to be obtained from having a more constant demand for power from the central station, is emphasised by the fact that in some cases electric current is supplied for manufacturing purposes at less cost than it can be produced for, owing to the demand from lighting and traction sources being so variable during the 24 hours, that a higher price has to be charged to cover the stand-by losses.

When the stations are of large capacity with sources of demand such as to render the average demand very close to the maximum output, the cost of production will be considerably reduced, and the charge per unit for all purposes will be reduced to as low a point as will allow of a reasonable profit being obtained. The item of cost of fuel per unit will become more prominent the nearer the average demand is to the maximum demand of the station.

It will be obvious to mechanical and electrical engineers that the smaller the unit of steam power that is replaced by electric power, the greater is the advantage to the user; steam can only be economically employed in such installations as will admit of the most efficient large power engines and boilers being used.

The author points out that the charge of 1d. per unit is too high for manufacturers who require large powers, and that unless the price is reduced to something like ¾d. per unit only the smaller manufacturers will benefit.

The usual reference is made to the water-power of the Niagara Falls, and the waterfalls of Switzerland, but as there is no such considerable source of power in England, the use of power gas and large gas engines is looked to as the only available source of cheap power for this country.

Referring to existing central stations working on power gas, the largest unit out of the total of seven stations was 200 H.P., and the largest station had an aggregate of 650 H.P.; the reason of this was said to be that until recently no gas producer was commercially available which could make a *reliable* gas sufficiently cheaply, or from any but expensive fuel, such as anthracite or coke; and secondly, no gas engines of large size had been in use for a sufficient period of time to satisfy electrical engineers as to their suitability for working under station conditions.

The author explains that these reasons exist no longer, as the Mond producer plant is capable of converting cheap forms of bituminous coal, or slack, into a clean gaseous fuel, suitable in every way for use in gas engines, and at the same time recovering the ammonia of the coal as a valuable by-product, at a net fuel cost per unit generated, including all cost of labour, repairs, &c., at the gas producer and recovery plant, of less than one-twentieth of a penny at the switchboard, this figure representing the cost under actual conditions of continuous running at Winnington, without allowing full credit for the sulphate recovered.

Without referring particularly to the 200-H.P. gas engine engaged in central station work, the author goes on to say that gas engines of 500 H.P. are already numerous, and that one of 650 H.P. has been at work over a year, while others of 1,000 and 1,500 H.P. are building.

On the Continent, where Mr. Humphrey has been studying the question of large gas engines, he has had the opportunity of seeing the easy and comfortable way in which the 650 H.P. Westinghouse engine does its work; Mr. George Westinghouse told him that the Westinghouse Machine Company had sufficient experience to make them feel quite confident of their ability to build 2,000 and even 3,000-H.P. engines, and to run them with perfect success.

The improvements in gas engines which have enabled them to be made of large power, and capable of being employed for central station purposes, include the more efficient water cooling of the liner, piston and valves; the better shape given to the clearance space; the introduction of induced and positive systems of scavenging, and the prevention of pre-ignition, together with the strengthening of all working parts.

Mention was made of the practice of the Westinghouse Company in making the crankshaft half the diameter of the piston, but though this may suit their three-crank system, it cannot be taken as a basis for designing gas engines, as the diameter of the crankshaft depends upon many conditions included in the design of the particular engine.

In designing gas engines of large power, the increased amount of heat to be dealt with becomes a serious matter to efficiently arrange for, and in engines of a type to give two impulses in one revolution the problem becomes still more complex.

The author then described 10 different large gas engines, which we may summarise as follows:—

1. A Crossley engine of 450 I.H.P., with two cylinders 26 inches diameter and 36 inches stroke, placed facing each other, having a crank common to both, running at a normal speed of 150 revolutions per minute, and driven by Mond gas.

2. A "Premier" engine of 650 I.H.P., with two cylinders, tandem, 28 inches diameter, 30-inch stroke, working at 150 revolutions per minute with Mond gas.

Each of these engines is direct-coupled to a dynamo, and runs continuously, supplying current for electrolytic plant.

3. A "Simplex" engine of 700 I.H.P. having a single cylinder of 51 inches diameter, and 55 inches stroke, running at 80 revolutions per minute, direct-coupled to a blowing engine, and driven by blast furnace gas.

4. An "Oechelhaeuser" engine, with two pistons in each cylinder, of 600 I.H.P., having two cylinders, 18·9 inches diameter, the stroke being 31·5 inches, and the speed 135 revolutions per minute, direct-coupled to a dynamo.

5. A similar type of engine to the above, except that only

one cylinder is used, of 25·6 inches diameter, rated at 600 I.H.P. In course of construction.

6. Another engine of the same type as the last, with one cylinder 36·8 inches diameter, and stroke 50 inches, to develop 1,000 I.H.P. In course of construction.

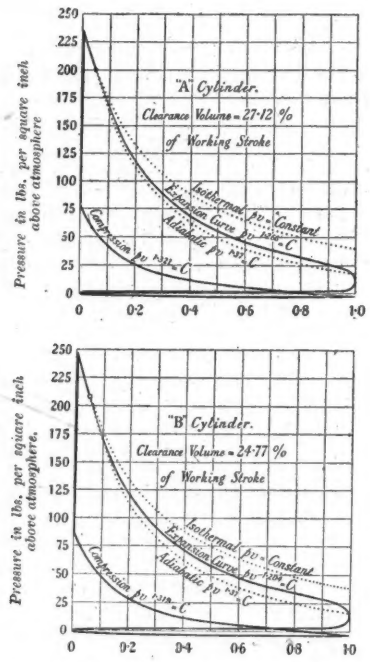
The author says that several engines of the two last sizes are being built.

7. A Westinghouse engine of 650 I.H.P., with three cylinders of 25 inches diameter and 30 inches stroke, at 130 revolutions per minute, driving a dynamo, direct-coupled. At work at Pittsburg, others building.

8. Westinghouse 1,500-I.H.P. engines, with three cylinders of 34 inches diameter and 60 inches stroke, to run at 100 revolutions per minute with natural gas. Two building. These are to be direct-coupled to dynamos.

9. Koerting Bros. double-acting 500-I.H.P. engine, with one cylinder 21·6 inches diameter, and 31·6 inches stroke, having a speed of 110 revolutions per minute, direct-coupled to a dynamo. In this type the gas and air are pumped separately and supplied under pressure.

10. Crossley 600-I.H.P. engine, with two cylinders 30 inches diameter and 36-inch stroke, running at a speed of 135 revolutions per minute on blast furnace gas. This engine has direct-attached blowing cylinders, forming the enlarged front portion of the motor cylinders, of 63 inches diameter.


"A" Cylinder.
Clearance Volume = 27·12 % of Working Stroke
Isothermal, pv = Constant
Expansion Curve, pv^1·32 = C
Adiabatic pv^1·41 = C
Compression pv^1·32 = C
Pressure in lbs. per square inch above atmosphere
"B" Cylinder.
Clearance Volume = 24·77 % of Working Stroke

The above indicator diagrams represent the average of all diagrams taken during the first six hours of the official trial, April 10th, 1900.

Fig. 1.—400-H.P. Gas Engine (Crossley). Indicator Diagrams.

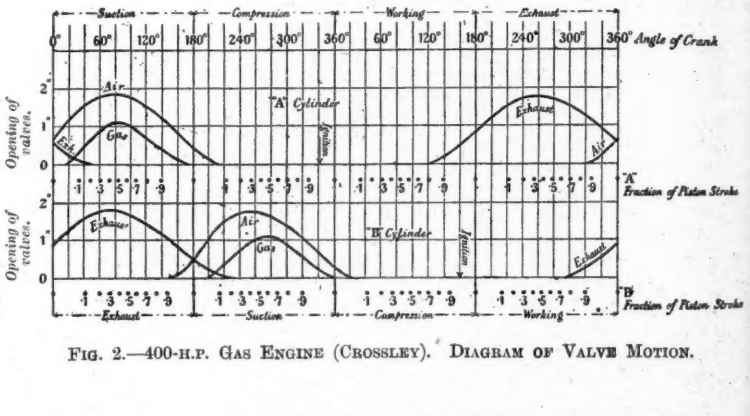


Fig. 2.—400-H.P. Gas Engine (Crossley). Diagram of Valve Motion.

The total weight of the rotating parts of the combined engine and dynamo is 87,638 lbs. Moment of inertia for all rotating parts (units in lbs. and feet) 62,654.

Weight of reciprocating parts, 2,080 lbs.

Weight of reciprocating parts per square inch piston area, 3·918 lbs.

Velocity of crank pin at 150 revolutions per minute, 23·57 feet per second.

The paper includes particulars of the acceleration of the reciprocating parts, in which the following approximate formula was used :—

$$A = \frac{dv}{dt} = \frac{d^2x}{dt^2} = q\,r\left\{\cos q\,t + \frac{r}{l}\cos 2\,q\,t\right\}$$

Where q = angular velocity of crank in radians per second.
v = linear velocity of crank pin.
x = displacement of piston from mid-stroke.
t = time. A = acceleration of piston.

The clearance volume of the engine cylinders was measured by filling the spaces with water from a tank balanced on a weighing machine.

Clearance volume	"A" cylinder ...	2·996	cubic feet.
" "	"B" " ...	2·740	"
" "	per cent. of working stroke "A" cylinder	27·12	per cent.
" "	per cent. of working stroke "B" cylinder	24·77	"
" "	per cent. of total volume "A" cylinder	21·34	"
" "	per cent. of total volume "B" cylinder	19·85	"

The resulting compression, as taken from indicator diagrams (average), was about as follows :

Compression in	"A" cylinder ...	76	lbs. per square inch.
"	"B" " ...	80	" "

The tabulated results of the tests made on July 2nd, 1900, and April 10th, 1900, are given in Table I on p. 145.

Average indicator diagrams, with isothermal and adiabatic curves, together with the equations to the actual expansion and compression curves, are given in fig. 1, and fig. 2 gives other information relating to the valve motion.

We notice that the piston speed, where particulars are given, ranges from 579 to 1,000 feet per minute, the latter figure being obtained by the Westinghouse type; the next highest is the Crossley 450-I.H.P. engine, with 900 feet per minute.

The mean pressures required to develop the powers stated are as follows :—

Mond gas ...	... 62 and 93 lbs. per sq. in.
Natural gas	... 71 and 108 lbs. per sq. in.
Blast furnace gas	... 50, 61·6, and 69 lbs. per sq. in.

The author gave particulars of tests carried out by him on the 400-H.P. Crossley engine, working with Mond gas, at the works of Messrs. Brunner, Mond & Co. This is a two-cylinder engine, having the open ends facing each other, and connecting rods working a crank common to both.

It is direct-coupled by a cheese coupling to a Mather and Platt 8-pole dynamo of 247·5 KW. capacity, separately excited, constructed to deliver 2,250 amperes at 110 volts.

A series of diagrams taken with a spring of 32 lbs. to 1 inch, showed the "bottom loop" or fluid pressures set up by the passage of the products of combustion out of the cylinder, and the suction pressure in drawing in the charges.

These have usually been ignored, but this should not be the case, as they are of great value in connection with the study of the gas engine.

It will be noticed from the diagrams that the compression in the Crossley engine is not very high considering the quality of the gas, but this was purposely kept low by the makers; the resulting mean effective pressure is only a little above 60 lbs. per square inch.

The 500-H.P. "Premier" gas engine, when tested with Mond gas at the works at Saniacre, showed a mean effective pressure of 103 lbs. per square inch. Both the above engines are direct coupled to dynamos.

The author, continuing, refers to Mond gas as a most perfect fuel for gas engines, but does not include in his paper a series of analyses to show the constant, or otherwise, quality of the gas; this would have been very interesting, as

we understand that the successful application of producer gas to the driving of gas engine has not resulted in more general adoption, owing mainly to the fact that the gas varies very

TABLE I.

Trial of 400-H.P. Gas Engine coupled direct to Dynamo.

	Trial at normal working load.	Trial at full load.
Date of trial	July 2, 1900.	April 10, 1900.
Duration of trial	2 hours	6 hours
Average output of dynamo, amperes	2,208·0	2,268·4
volts	98·6	110·0
E.H.P.	291·8	334·4
Average revolutions per minute ...	152·4	148·5
Mean effective pressure, average for "A" and "B" cylinders	51·37	60·43
Average indicated horse-power ...	377·9	432·9
Total Mond gas as measured by meter, cubic feet	49,640	176,820
Gas used per hour, reduced to 0° C. and 760 mm.	2,271	2,716
Analysis of dry gas:—		
CO_2 vol. per cent.	14·5	15·0
CO " "	12·0	11·5
H " "	29·0	28·5
CH_4 " "	2·0	2·1
N " "	42·5	42·9
Calorific value of gas:—		
Kilo-calories per cubic metre at 0° C.	1,444·5	1,423·5
Lb.-degree heat units per cubic foot at 0° C.	90·13	88·86
Mond gas used, per I.H.P.-hour, cubic feet at 0° C. ...	60·09	62·74
" E.H.P.-hour, cubic feet at 0° C. ...	77·82	81·22
" KW.-hour, cubic feet at 0° C. ...	104·3	108·8
Efficiency of dynamo, maker's figure, per cent.	93	93
Mechanical efficiency of engine, per cent.	83·04	83·06
Combined efficiency, E.H.P./I.H.P. per cent.	77·23	77·25
Thermal efficiency, calculated on the I.H.P., per cent.	26·23	25·49
Ditto, calculated on the B.H.P., per cent.	21·78	21·17
Ditto, calculated on the E.H.P., per cent.	20·26	19·69
H.P. absorbed in fluid resistances...	29·20	27·80
" " " engine friction...	34·90	45·53
Total frictional losses H.P. ...	64·10	73·33

largely in its thermal value within comparatively short intervals of time, and this change is more noticeable between the times of clinkering. Possibly, owing to the special conditions in the Mond producer, the gas is of a fairly constant quality, and a series of analyses taken at short intervals over a couple of days would have confirmed this.

Reference was made to the natural gas in use in Pennsylvania and other districts of America having given a stimulus to gas engine employment in the United States, and figures were given showing that a small Westinghouse engine had given a thermal efficiency with this gas of over 24 per cent., calculated on the B.H.P., but it was considered that in a comparatively few years' time this source of gas supply would be practically exhausted.

(To be continued.)

CORRESPONDENCE.

British Electrical Superannuation Fund.

Some few months ago I made an announcement with reference to a superannuation scheme which had recently been authorised by the shareholders of the B.E.T. Company, and as the scheme in its early stages attracted much attention, it is possible that many of your readers may be glad to know that the British Electrical Superannuation Fund is now fully constituted, with Lord Vaux of Harrowden and Mr. George Herring as investment trustees, and with a representative committee of six acting as managing trustees.

The staff of the B.E.T. Company has given the fund satisfactory support, and our associated companies have now been invited to join. I should explain that the rules of the fund have been drawn up expressly with a view to enable any electrical company to participate in the scheme, should it wish to do so.

The broad lines of the scheme are as follows:—

The funds will be invested in the names or under the legal control of the investment trustees. Careful consideration has been given to the investment clause with a view to secure as high a rate of interest as is compatible with safety. This object has been attained by giving the trustees a very free hand in regard to the character of the investments they may make, but strictly limiting their powers in regard to the proportion of the total funds which they may place in any one company or form of security.

The affairs of the fund will be under the immediate management of an elective committee equally representative of the contributing companies and the contributing members. A quinquennial valuation of the fund by two independent actuaries is provided for, stringent rules ensuring that the report made by the actuaries shall not be disregarded.

Speaking generally, each contributing company must make monthly a contribution equal to 3 per cent. of the monthly salary of each contributing member on its staff, and the member himself must make monthly a contribution equal to 2½ per cent. of his monthly salary, plus, in the case of those over 24, a certain extra percentage, varying with age.

The "retiring age" is 60, and a member must be of at least 10 years' standing before he is entitled to a pension. Upon retirement a member will receive, for every year of his service $\frac{1}{60}$th of the average annual salary received by him during the seven years preceding retirement, the maximum scale of pension being ⅔rds of salary. It is important here that service with any and every contributing company counts towards pension, so that an officer can pass from the service of one such company to that of another without injury to his pension prospects.

This scheme, I should add, is intended to apply only to those members of the staff of a contributing company who are on the monthly salary list, and who are between the ages of 18 and 45.

For the provisions which exist in regard to members who wish to reckon their back years of service, in regard to members whose percentage contributions are heavy by reason of their age, and in regard to the contributions of and on behalf of the present staff of a contributing company, I must refer any firm interested to the trust deed and rules which are to be had on application at this address, to Mr. W. G. Bond, the secretary of the fund.

E. Garcke,
pp. W. G. B.

Donington House,
Norfolk Street, Strand, W.C.,
January 23rd, 1901.

Corporation Contracts.

I notice in this week's notes that you insert a paragraph with reference to the correspondence I sent you in regard to the Devonport switchboard contract, and that you invite further correspondence on the subject. Curiously enough, we have had two further instances of similar treatment. In the one case, that of the Plumstead Vestry, which we believe is now styled the Borough of Woolwich, the contract was placed at a considerable increase on our tender, and we had the admission of the engineer on the telephone that our tender and everything else was in order. On writing to him to know the reason of the tender being placed elsewhere at the higher figure, he writes: "The bye-laws prevent me answering your question."

In the other case the facts are very similar.

Williamson & Joseph, Limited,
Edward L. Joseph.

January 22nd, 1901.

The Dangerous Third Rail.

With reference to my question for which you kindly found space last week, the report of an inquest, printed in the *Daily Telegraph*, January 19th, seems to disprove the reported statement of an official of the Twopenny Tube as to the rail's inability to injure a person.

May I refute the statement made at the inquest, "there were no means by which it (third rail) could be protected?"

In America, where lives are a first consideration, I have seen on the New York overhead system a wooden guard on each side of the third rail (about 7 inches apart, and 3 inches above the rail), and anyone could fall across these guards without the possibility of touching the dangerous rail. I enclose copy of the report referred to. I have seen pictures of this protected third rail in New York illustrated papers.

A Medical Man.

January 22nd, 1901.

High Voltage Arc Troubles.

Referring to the note in your issue of January 4th on "One Method of Dealing with the High Voltage Arc Lamp Trouble," will you allow me to say that I have patented a H.V. arc lamp, which I venture to think provides a better solution of the difficulty than a separate service? In this lamp two arcs are connected in series in one lamp (they may be in the same or separate inner globes), and are controlled by a single mechanism as simple and reliable as that of the simplest single-arc lamp, which yet provides for unequal rates of burning of the two pairs of carbon.

Arthur J. Hills,
c/o Messrs. Cathcart & Co.
2, Dorset Buildings,
Salisbury Square, E.C.

Information Wanted.

Can you, or any of your readers, tell me how to recharge dry cells?

Enquirer.

[We have charged some such cells with a small current from storage cells, for long periods, but the effect, though marked at first, soon disappeared in use; perhaps some of our readers have been more successful.—Eds. Elec. Rev.]

Correction.

We are surprised to find in your issue of the 18th inst. a copy of a letter published by Messrs. Maguire & Baucus in their advertisement on page 22 of the Supplement.

We, together with two other firms in England, are the sole agents for Messrs. Bergmann & Co., of Berlin, and upon seeing the above advertisement immediately wrote to Messrs. Bergmann for an explanation, and they reply by telegram:—

"Publication Edison letter by Maguire, Baucus unauthorised."

In justice to ourselves and the other firms acting as agents, we shall be much obliged if you will give this letter prominence in your next issue.

Bergtheil & Young.

January 22nd, 1901.

Capacity in Alternate Current Working.

In connection with Mr. Mordey's paper under the above title, read before the Institution of Electrical Engineers on January 10th, might I suggest that a far better way of measuring dielectric hysteresis loss than the one he employed, is to put the dielectric of the cable *in series with* a suitable choking coil *without iron*, and arrange matters so that the current through them is approximately in phase with the P.D. of the alternator. An ordinary wattmeter would then measure the power spent in cable and choker with fair accuracy. The watts spent in the ironless choker can be determined by c^2r, and deducted from the wattmeter reading.

Prof. Ayrton agrees with me in thinking that the method here described is even better than the one he suggested in last week's *Electrician*, in which the cable and ironless choker were in parallel.

As the P.D. of the alternator would only require to be *a small fraction* of that between the inner and outer conductors of the cable, there would be no need to use transformers for reducing the P.D. on the pressure coil of the wattmeter, or to extend the experiment over several hours to get a reading. An electrostatic voltmeter would, of course, be used to measure the pressure to which the cable is subjected.

I hope to give a description of a choker of variable inductance *without iron* in the discussion on Mr. Mordey's paper.

Before concluding, I may remind you that the method here suggested enables cables to be tested to much higher pressures than that produced by the alternator used, and without the use of step-up transformers.

T. Mather.

January 25th, 1901.

LEGAL.

Lane *v.* Elliott Bros.

Mr. Justice Ridley in Queen's Bench Division on Thursday, January 17th, delivered his reserved judgment in the case of Lane *v.* Elliott Bros., which was reported in the Electrical Review last week. The plaintiff, Mr. Ruben Lane, chartered accountant, sued as receiver for the debenture holders of a company called the New Fowler-Lancaster, Limited. This company after reconstruction altered its title to Fowler-Lancaster, Limited, and that name was duly registered at Somerset House, but the secretary omitted to apply to the Board of Trade for its sanction, which was necessary under the Companies' Acts. Subsequently Fowler-Lancaster, Limited, continued its business, and undertook certain electrical work for the Brighton Corporation, on which £269 balance of account was still due. Defendants, Messrs. Elliott Bros., are a firm of electrical engineers, and they carried out the work under contract with the Fowler-Lancaster, Limited, and since had obtained a garnishee order on the sum due. Plaintiff, by this action, sought to recover the money, on the ground that the Fowler-Lancaster, Limited, having no legal existence, the contract was really with the old company, and the debenture holders were entitled by prior claim to its property.

Mr. Justice Ridley said the whole issue turned on the particular description of the company. In his opinion the debenture holders, under the receiver appointed by the Court, took preference over defendants in respect of the sum from the Brighton Corporation. It had been ably argued by Mr. Lochins, for the defendants, that because the company's real name was New Fowler-Lancaster, Limited, and that the debenture holders rights, whatever they were, were in respect of that company, they could have no rights as against Messrs. Elliott Bros. to receive this money, because the defendants had contracted, not with the New Fowler-Lancaster, Limited, but with Fowler-Lancaster, Limited, which company had no debentures. It was contended that any proceedings between the company and Elliott Bros. became void. His Lordship did not think that that could be the law. It was true that where a company traded in a name that was not its own, the directors became personally liable. That was enacted for the security of creditors. In the case of Atkin *v.* Wardle it was decided that directors who represented the South Shields Salt Water Baths Company, Limited, and who accepted a bill in the name of the "Salt Water Baths Company, South Shields," were personally liable, although it was not said that the company was not liable. In the present case, the question was whether the company was liable, and he was clearly of opinion that it was. Here there was but one company, and the only thing that had happened was that they traded in a name which they thought to be the right one, but which turned out not to be the right one. He was of opinion that the debenture holders had a right to take this money, and that therefore judgment ought to be entered for the plaintiff on the issue.

Judgment for plaintiff accordingly.

Chaplin & Co., Limited, *v.* the Corporation of Westminster.

This was a motion by the plaintiffs, who are wine merchants in Villiers Street, Strand, seeking to restrain the Mayor, Aldermen, and Council of Westminster from erecting any structure or post on the west side of Villiers Street so as to cause an obstruction of the access to the plaintiffs' premises there and in Craven Passage. The motion came before Mr. Justice Farwell, in the Chancery Division, on Friday. Counsel for the plaintiffs stated that Chapman & Co. had large warehouses on the south side of Craven Passage, and the only way they could get in cases and casks to their cellars to or from vehicles was by bringing them to or from the Passage to or from Villiers Street where the carts stood. The street was not

wide, and it was now lighted by electricity. Almost immediately opposite Craven Passsge, on the east side of Villiers Street, there was an electric lighting post. The occupant of the shop on the east side objected to its position, and the Corporation now proposed to remove it, and erect it on the west side, in the middle of the entrance to Craven Passage, thus cutting in two the access to a passage which was only 30 feet wide at present. This, plaintiffs submitted, would hamper them in the conduct of their business as it had been carried on hitherto, and would besides be a source of danger to their employés and also to foot passengers in the street.

Mr. Butcher, Q.C., for the Corporation, said that the matter had been well considered by the Corporation and also by the late Vestry, and these bodies, acting in the public interests, had come to the conclusion that the site now proposed was the proper one on which to erect the lamp, and that the plaintiffs' complaints were unfounded.

His Lordship, in giving judgment upon the motion, said that the point was—on which side was the balance of convenience? The street at present was lighted by a lamp on the east side. The Corporation proposed to remove it to the west side. They were not justified in doing so if it were a nuisance to a private individual. *Primâ facie*, on the affidavits which had been presented to the Court, it was a nuisance; and inasmuch as there was no necessity for removing it at present, he thought that the defendants should be restrained until the trial of the action from removing the lamp to a place where, *primâ facie*, it would be a nuisance.

Interim injunction until the trial was accordingly granted, and his Lordship directed that the costs of this motion should be made costs in the action.

City of London Electric Lighting Company, Limited, *v.* the Mayor, &c., of London.

This case came before the Court of Appeal, composed of the Master of the Rolls and Lord Justices Collins and Romer, on Monday and Tuesday last, on the appeal of the defendants from the order of Mr. Justice Farwell, in the Chancery Division, dated May 3rd, 1900.

Mr. Swinfen Eady, Q.C., in opening the case, said it was the appeal of the Corporation of the City of London, the defendants, from the judgment of Mr. Justice Farwell at the trial of the action. The plaintiffs, the City of London Electric Lighting Company, Limited, by their statement of claim sought a declaration that the defendants were bound by certain agreements, electric lighting agreements. That was the whole relief claimed. The defendants' case was that the Corporation were not bound, as certain members of the Commissioners of Sewers, to whose position the Corporation were successors, were interested in the contracts, contrary to the statutes, and that the contracts were thereby avoided. Mr. Justice Farwell decided in favour of the plaintiffs, and adversely to the defendants, on the grounds that the class of contracts which the statute made void if the Commissioners were interested in them, were contracts for works as distinguished from contracts to supply gas, water, or electric energy, and that the persons interested were only interested as shareholders in the company. The contention on behalf of the appellants was that the learned judge in the Court below was wrong on both points. The question turned on the construction of the Commissioners of Sewers' Acts of 1848 and 1851. The contracts in question were entered into in 1890 or 1891, with the Brush Electrical Engineering Company, of which the plaintiffs were assignees, and had been acted upon by both parties. There were three separate contracts for the lighting of the central, eastern and western areas of the City. As regarded the central and western, at the time the contracts were made there were among the Commissioners of Sewers certain Aldermen and Common Councilmen who were also shareholders in the Brush Electrical Engineering Company, Limited, with whom the contracts were made, the suggestion being that if they were members of the company which entered into the contract, the compact was null and void. The third contract was entered into when no member of the Commissioners of Sewers or Alderman or Common Councilman was a member of the contracting company, but subsequently certain shares were taken in the plaintiff company by members of the Corporation, and the suggestion was that even that fact rendered the contract null and void. In the case of the Eastern District, the original contract became vested later in the plaintiff company, of which some members of the Corporation were shareholders, and the case for the defendants was that that made the contract null and void *ab initio*. The case for the appellants was that under the Commissioners of Sewers' Act of 1848, if any alderman or common councilman was directly or indirectly interested in any contract for works, &c., with the commissioners, such contracts became null and void. The learned counsel contended that a shareholder in a company was a person interested in the company. These contracts were not merely contracts to supply electricity, but contracts to execute "works" in respect of which there was a detailed specification, which was not to be departed from.

Mr. Danckwerts, Q.C., followed on the same side.

Mr. Cripps, Q.C., on behalf of the respondents, upheld the decision of Mr. Justice Farwell, contending that the prohibition applied only to contracts for works and not of supply, as otherwise it would be in the power of any Common Councilman by taking shares in a contracting company to plunge the City in darkness.

Mr. Swinfen Eady, Q.C., having been heard in reply, their Lordships reserved judgment.

LONDON COUNTY COUNCIL.

The Council at the meeting on Tuesday authorised an expenditure of £750 in connection with the electric lighting of the East Greenwich Fire Station, for which tenders will be invited in due course.

Electric Traction on the North Metropolitan System.—The Highways Committee reminded the Council of the following resolution passed in November:—"That in view of the desirableness of no longer withholding from North and East London the advantages of electric tramway traction, and of the importance of providing a complete and united system of electric tramway intercommunication between the different parts of the metropolis, the Highways Committee be instructed to ascertain from the North Metropolitan Tramways Company at what price they will surrender the lease now held from the Council, which expires in July, 1910." This resolution was communicated to the company with a request that the directors would take the matter into consideration and state on what terms the company would be prepared to surrender the lease. In this connection the Committee now reported that a letter dated December 21st had been received from the managing director of the company stating that he was requested by the directors to say that they were not prepared to name any price for the relinquishment of the lease.

Mr. M. Beachcroft, on the motion for the reception of the report, asked the chairman of the Highways Committee whether it was a fact that the lease of the North Metropolitan Tramway Company bound the company to reconstruct the lines for electric traction or to allow the County Council to do so; if so, whether there was anything to prevent the Council from enforcing the provision; whether the Committee had before it the joint report of the officers as to the financial results for giving effect to those clauses; if so, was there any reason why the Council should not be informed on the subject; and whether it was correct to say that electric traction was being withheld from the North and East of London in consequence of a lease being granted to the tramway company.

Mr. J. W. Benn stated, in reply, that it was true the lease contained such provisions as had been mentioned, but they were not the only provisions. The officers had reported to the Committee that the adoption of electric traction was possible and favourable to the Council, and the Committee would have reported to the Council, but for the fact that they felt it necessary to inquire what the financial results would be if the lease was acquired, and the Council itself carried out the electric traction scheme. In reply to further questions, the speaker read the letter received from the company, which he said did not close the matter, as it did not say that the company were not prepared to receive an offer for the surrender of the lease. The Committee would be able in about three weeks' time to invite the members of the Council and of the borough councils to witness an object lesson of the conduit system at Camberwell, where a car was now running. There was no great delay being incurred in the matter, and the specifications had already been printed. In about 18 months to two years the Council would have the conduit system, and probably one or two others satisfactorily in operation in London.

The report of the Committee was then received.

Extension from Tooting to the County Boundary.—In a further report the Highways Committee stated:—

The Council on October 30th last decided on our recommendation to seek powers to extend its tramways from the present terminus at High Street, Tooting, to the county boundary at Waterfall Bridge. In our report presented on that day, we stated that this extension would largely increase the value, from a traffic point of view, of the proposed tramways from Wandsworth *via* Garratt Lane to Tooting, as to which the Council had previously decided to seek powers, and further, that it could be worked in conjunction with the tramways, in respect of which the Wimbledon Urban District Council then contemplated obtaining powers, from Wimbledon *via* Merton Road and High Street to the boundary of that Council's area of jurisdiction at Waterfall Bridge. The Wimbledon Council has since decided not to proceed for the present with the proposal referred to. This decision is of some importance as affecting the proposed extension of the Council's tramways to Waterfall Bridge: but as we consider that the extension will be advantageous, and will, moreover, enable improvements to be effected in the existing tramways service, we think that the Council's proposal should still be proceeded with.

Extensions of Works.—It was decided on the recommendation of the Building Act Committee to approve a further variation from the plans submitted on behalf of the Hampstead Borough Council for an extension of the generating station in Lithos Road; to sanction plans forwarded for the rebuilding of generating station and works in Springfield Road, Sydenham, for the Crystal Palace District Electric Supply Company, and to approve plans for the construction of a sub-station in Yukon Road, Balham, for the County of London and Brush Provincial Electric Lighting Company.

FATALITY ON THE CENTRAL LONDON.

On 18th inst. Mr. John Troutbeck held an inquiry at the Court in Horseferry Road, S.W., concerning the death of Albert Pantling, aged 33 years, a ganger of platelayers in the service of the Central London Railway Company, who died in King's College Hospital on the 15th inst., from the effects of injuries sustained under extraordinary circumstances on the night of December 25th.

A Platelayer gave evidence to the effect that when he was cleaning a hand lamp at the British Museum station, a few yards from where the deceased was, he heard a loud report and saw a

flash where the deceased stood. He went at once to see what was wrong, and found the deceased's clothing burning. His first thought was to extinguish the fire, but as it was such a dangerous place to stand on he considered it prudent to get him out, so that he should not have another severe shock.

H. H. Holt, one of the railway engineers, said it was absolutely necessary to have the current rail exposed, and there was no means by which it could be protected. It was necessarily exposed because the shoe of the locomotive had to take up the current from it.

H. Wells, permanent way inspector, deposed that he was pointing out to Pantling a little job he wanted him to do that night. He was standing near the crossing, about two yards from the deceased, who was on a piece of timber, when he (witness) accidentally touched the current rail with his 2-foot rule, which was "metalled" down all the way. In a moment there was a flash, which temporarily blinded witness, and he could not see the deceased, although he heard him fall. Witness asked him whether he was hurt, and he replied "I am all right," but directly after that he began to shout. Witness could not see him, however, for several seconds.

H. H. Holt, recalled, said that if a man stood with one foot on the current rail, and the other on the running rail, the current would go through him. The current would represent about 500 volts of electricity, which would not necessarily kill him. Witness had received such a shock accidentally many times. Of course, it startled one very much. It was possible for one to walk on the current rail without being injured.

E. M. Malek, chief assistant power engineer to the company, stated that the fact of Pantling's clothes being on fire when Casbeard arrived on the scene was a thing he personally could not explain.

The Coroner: Can you suggest any means of protecting persons who have to work on the permanent way, which, of course, must be seen to?—The permanent way is inspected, and I believe no actual work is done on it until the current is cut off. At this very point the permanent-way inspector was telling the deceased, who was the ganger, what he wanted done somewhere else, and he was demonstrating what the job was when this happened. Anybody might receive a shock.

George Hammond, station master at the British Museum, who witnessed the accident, said he heard two reports. If the current had been going through the deceased when witness got up to him, he must have received a shock as well, but he did not. It was a wet evening, and Pantling's clothes were damp and sticky.

Mr. R. S. Cope, house surgeon at King's College Hospital, spoke to admitting the injured man shortly before midnight on Christmas Day. Death took place on Tuesday last week from general blood poisoning, due to absorption, the result of the burns.

The Coroner said the case was an important one. The possibility of such an accident as this occurring on a public line was a very serious matter. What they had to consider was whether the deceased met his death through the culpable negligence of any person, it being perfectly clear that these fatal burns were inflicted through Wells's action in placing his rule on the metals, thus causing a great flash and a loud report, or two reports, as the station-master had said. No doubt the man was burnt by the electric current; that was perfectly obvious. As to whether any alteration could be made, that was beyond them as a jury altogether, he thought. The Board of Trade had had its attention called to the matter, and its railway department had means of making inquiries into such cases; in fact, it was one of its chief duties to do so, and to insist on such amendments being made as it considered necessary.

The jury concurred in the coroner's remarks, and returned a verdict of "Accidental death."

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"Vibration" writes:—"I should be glad if you would send me some information upon the following points:—My house at A. is situated near, but not exactly over, a deep tunnel electric railway, and I am owner of other property at B, underneath which a company proposes to obtain Parliamentary powers for the construction of a similar line. When the scheme for promotion of the existing tube was before Parliament, I took no steps to obtain compensation, or any special protecting clause. The vibration caused by passing trains seriously interferes with the comfort of my house, and inasmuch as all the houses immediately above and in the neighbourhood of the route are similarly affected, I apprehend that the value of my property at B. may be seriously diminished in the near future. Would you be so good as to inform me whether—

1. "I can recover damages from the existing railway company for the nuisance caused by vibration.

2. "Opposition to the Bill which is about to be introduced during the next session of Parliament will be likely to have any useful effect."

*** The questions put by our correspondent have recently attracted the attention of those who write letters to the daily papers. We presume that our correspondent is affected by the working of the Central London Railway, and that his property at B is situate along the route of some of the other tubes which various companies are proposing to drive through the London clay.

The answer to the first question addressed to us appears to be completely furnished by the case of the Hammersmith and City Railway Company *v.* Brand [L.R., 4 H.L., 171] which is usually cited as an authority for saying that it is a good defence to an action to show that what is *primâ facie* a nuisance, arises unavoidably from the performance by the defendants of acts expressly sanctioned by the Legislature. When we remember that Hammersmith *v.* Brand was a decision of the House of Lords, it is not likely that the principle laid down therein will be overruled. It was there decided that the Lands Clauses Consolidation Act and the Railways Clauses Consolidation Act do not contain any provisions under which a person whose land has not been taken for the purposes of a railway, can recover statutory compensation from the railway company in respect of damage or annoyance arising from vibration occasioned (without negligence) by the passing of trains, after the railway is brought into use, even though the value of the property has been actually depreciated thereby.

With regard to the second question addressed to us, it is possible that, having regard to the outcry which the running of trains has caused all along the route of the "Twopenny tube," committees in Parliament may alter the course which they have hitherto adopted in relation to claims for compensation. It was thought when the Central London Railway Bill was under discussion—and the presumption was founded upon evidence of the greatest weight—that the running of trains at deep levels would cause no appreciable vibration at the surface. Experience has proved otherwise. We may therefore presume that freeholders and dwellers in the neighbourhood of such railways will obtain a hearing in future.

According to a letter which appeared in the *Times* of December 26th, it seems that when the Central London Railway Bill was before the Committee, a freeholder of the land on both sides of Oxford Street, who was therefore owner of the whole of the subsoil below the surface of the street, appeared by counsel in opposition to the Bill. It was argued on his behalf, that he was entitled to be served with a notice to treat, and that he should be awarded damages possibly only on a nominal sum for the subsoil which was to be taken from him compulsorily. The Committee reserved their decision, but eventually decided against the freeholder. Seeing that the *locus standi* of a freeholder has been denied before Parliamentary Committees, it stands to reason that a person in the position of our correspondent can hardly expect to have his claim admitted, unless some change of procedure similar to that which we have above anticipated takes place in Parliament.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Jan. 23rd, 1900.		Week ending Jan. 22nd, 1901.	
Auckland	Value £121	Adelaide. Teleg. mat.	Value £1,300
Bangkok	127	Amsterdam	125
Bombay	7	Bangkok	225
Calcutta	267	Beira	203
„ Teleg. wire	93	Bombay	53
Callao. Teleg. wire	64	Brisbane	30
Cape Town. Teleg mat.	1,008	Calcutta	1,450
Channel Islands	1,140	Colombo	75
Chinde. Teleg. mat.	3,322	Copenhagen. Teleg. wire	187
Christiania. Teleg. wire	29	Durban	368
„ Teleph. cable	950	Fremantle	14
Copenhagen. Teleg. cable	167	Gibraltar	14
Durban	68	Hamburg	68
„ Teleg. mat.	232	„ Teleg. mat.	400
East London	71	Havana. Teleg. mat.	50
Flushing. Teleg. mat.	96	Kobe. Teleg. cable	2,808
Gibraltar	192	Launceston	365
Halifax	80	Lyttelton	49
Hong Kong	624	Melbourne	80
Malaga	100	Nagasaki	632
Marseilles. Teleg. cable	1,294	Ostend	75
Mauritius	352	Perth	58
Montreal	54	Port Chalmers	194
Ostend	87	„ Elizabeth. Teleg. mat.	152
Port Chalmers	35	St. Petersburg	57
„ Elizabeth	172	Sascho. Teleg. cable	2,740
„ „ Teleg. mat.	231	Shanghai	167
Shanghai	207	Singapore	40
Singapore	52	Sydney	1,967
Stockholm. Teleg. mat.	171	„ Teleg. wire	164
Sydney	1,294	„ Teleph. cable	2,150
Valparaiso	36	Wellington	433
Wellington	145	Yokohama	3,912
Yokohama	568	„ Teleg. mat.	47
Total	£13,456	Total	£20,742

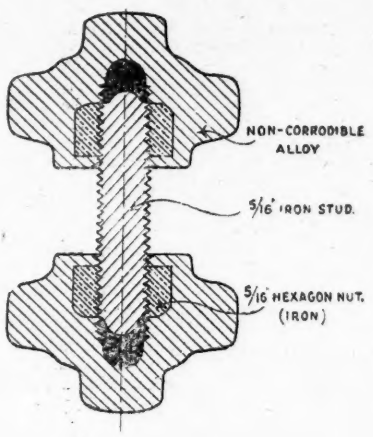
Foreign Goods Transhipped.

Brussels. Electl. goods.	Value £45
Paris. Electl. goods	15
Perth. Electl. appar.	2,350
Total	£2,410

Annual Dinner.—The third annual dinner of the Langdon-Davies Electric Motor Company, Limited, was held on the 12th inst., about 50 being present. Mr. A. Soames (managing director of the company) presided, and was supported by the directors. After dinner a capital musical programme was provided by members of the firm and friends.

Austria.—The report of the Austrian Schuckert Electrical Company, of Vienna, for the financial year, 1899-1900, shows that during that period the company supplied 618 dynamos of a total of 18,740 H.P., as against 496 machines of 9,510 H.P. in the previous year. During the year the company completed one central station, eight enlargements, an electrical tramway, and 127 private installations.

Battery Connecting Bolt.—Messrs. W. O. Rooper and Robins, of Stafford, send us a copy of their new price list of Epstein storage batteries, which they have been manufacturing for some time. Special attention is drawn to Rooper's patent battery connection, by means of which any plate in any cell can be removed, and replaced in a few minutes. Each plate has a jaw formed on its lug, and through the jaws is passed a lead-coated pin; spacing washers keep the jaws in the right position, and the whole is



tightened up by means of the firm's patent nuts, which are impervious to any action of acid. We have before us a sample of their battery connecting bolt with patent nuts (see illustration), which are intended to be used in place of the ordinary brass bolts, in order to prevent the inevitable corrosion, which now takes place with its consequent deposit of copper in the cells. We understand that joints made in this way can be left in strong acid without harm, and no trace of corrosion found on removal.

Books Received.—"The Automotor and Horseless Vehicle Pocket-Book of Automotive Formulæ and Commercial Intelligence for 1901." London: F. King & Co., Limited. 1s. 3d. and 2s. 3d.

"Meteorological Observations made at the Adelaide Observatory, 1897." Adelaide: By Authority. 1900.

"Electricity," by J. D. Everett. London: Blackie & Son. 4s. 6d.

Cable Clips.—Messrs. W. N. Brunton & Son, of Musselburgh, send us a circular illustrating their clincher cable clip, which is claimed to possess many advantages over the raw hide clip that has been used in the past. It has two hooks on each clip to secure it to the carrying wire, and is adjustable for any size of cable. The cable can be gripped either tight or loose, and the heavier the cable, the more secure is the fastening.

Catalogues and Lists.—Mr. S. Jevons, of Birmingham, has issued illustrated price lists of Offord & Jevons's automatic time switches for arc, incandescent, and motor circuits; also of Chaplin's patent sparkless "Gem" brushes for dynamos, motors and rectifiers.

Price list No. 6 of the Electrical Company, Limited, contains prices of "A," "Eos," and "Luna" carbons for "Luna" arc lamps. No. 7 gives details, with numerous illustrations, of various safety fuses, cut-outs, fuseboards, ceiling roses, and fuse wires.

The Cape Asbestos Company, Limited, sends us 1901 refills for its desk blotting pad, circulated last year.

The B.T.H. Company's pamphlet No. 85 describes polyphase induction motors.

The Hart Accumulator Company, Limited, has brought out a catalogue, in which detailed instructions for erection and working are followed by tabulated particulars of the Hart cells for lighting and traction work, in glass and lead-lined boxes. The information is very clearly arranged and neatly printed.

The Electrical Supply Company, of Hatton Garden, sends us a neat desk-standing calendar for 1901.

English Engines of 5,000-I.H.P.—The Glasgow Corporation it will be remembered placed the contract for some of the large engines for the tramway generators with Messrs. John Musgrave & Sons, Limited. It will be interesting to our readers to note that one of these 5,000-I.H.P. engines is now nearing completion at Bolton. It is believed to be the largest stationary engine for traction purposes ever made in this country. We congratulate Messrs. Musgrave on the approaching fulfilment of this very important contract, and also the Glasgow Corporation on its endeavours to adopt machinery of British manufacture.

Electrical Development in Spain.—The Madrid correspondent of the *Financial News* makes some comments on foreign enterprise in Spain which will be of interest in connection with the promotion of tramway undertakings by English firms:—As everyone knows, Spain is badly in want of foreign capital to work its mineral wealth, and generally to endow the country with improvements more in harmony with modern civilisation. Nevertheless, the law which has just been enforced is, apparently, not of such a nature as to encourage foreign capitalists and manufacturers to devote themselves to enterprise in Spain. The following is the text of the said law, as published by the *Gaceta*:—

Henceforth no one can become a concessionnaire of railways or tramways, either for general or private use, except he be a Spanish citizen residing permanently in Spain. Syndicates and public companies may own lines, but must submit to the following conditions:—(*a*) Their offices must be situated in Spain, and all their operations be ruled exclusively by Spanish law; (*b*) They must state the nominal value of their shares and debentures in Spanish currency, and pay the dividends and interest in a like manner; (*c*) At least one-third of the members of the board of directors must be of Spanish nationality, and, moreover, permanently residing in Spain; (*d*) The managing directors, engineers, and head officials must be Spanish subjects and permanent residents in Spain; their nomination must be finally sanctioned by the Government. Only in very few and exceptional instances will foreigners be eligible for appointment.

This enactment, as the work of a Government which is supposed to encourage foreign enterprise, may truly be described as the climax of absurdity.

The English Electrical Fittings Trade.—We have received the following circular from Mr. W. Arthur Addinsell, secretary of the China Furniture and Electrical Fittings Manufacturers' Association, 112, Edmund Street, Birmingham, dated January 21st:—

"*Protection of English Trade in Electrical Fittings.*

"For some time past the manufacturers of china and porcelain electrical fittings have conferred with their principal customers, who comprise the largest buyers of these articles, as to the best means of preventing foreign-made china being disposed of in this country as of English make. A joint committee of manufacturers and customers has been formed, and during the last three years meetings of such committee have been held. At a recent meeting it was suggested by the customers that a trade mark should be adopted by the manufacturers, and that all china or porcelain electrical fittings sold in this country should be marked so that the electrical engineers or direct consumers who specify for English china would be able to tell that such china is supplied." . . . .

"All goods made by the manufacturers since the 10th instant will be marked with a special trade mark, and from henceforth electrical engineers, in specifying for English china, will be able to assure themselves that they get it. It must be borne in mind that some work in the process of manufacture and in stock now held by the manufacturers and also stock held by their customers will have to be sold unmarked, but in the event of any goods being supplied to electrical engineers about which they have any doubt as to the make, the same can easily be identified if samples are sent to me. It has been stated that importers of foreign china have been in the habit of mixing a small quantity of English china with such imported goods and then representing the bulk as being of English manufacture. By the adoption of the trade mark it is hoped that the interests of the manufacturers, their customers, the electrical engineers, and the direct consumers will henceforth be protected; at all events, there can be no doubt that this will be the result if electrical engineers will make a point of specifying for the china or porcelain to be of English manufacture."

For Sale.—Messrs. Horne & Co. are instructed by the Electric Traction Company, Limited, to sell, by auction, on the premises, Wood Lane, Shepherd's Bush, on Tuesday, February 26th, 1901, and following days, the remainder of the machinery and plant recently used in the construction of the Central London Railway. Catalogues (when ready) may be obtained of Messrs. Horne & Co., 8, Delahay Street, Westminster, and 85, Gresham Street, E.C.

Further particulars are given in two advertisements to-day of the auction sale of electrical and other machinery, also gas engine and Dowson gas producing plant, to be conducted by Messrs. Wheatley Kirk, Price & Co., on February 5th and 6th, at Brook Street, W.

In our advertisements to-day are given some particulars of the plant and stock of the Acetylene Light Syndicate, Limited, which are being offered for sale by private tender by the receiver.

Messrs. Tresidder & Company, valuers and auctioneers, of 2, West Chapel Street, Mayfair, W., are instructed by the Liquidator of the Universal Electric Advertising Syndicate, Limited, to offer for sale by tender an alternating electric sign which was formerly working at the corner of Tottenham Court Road. It has now been taken to pieces, and is being stored by Messrs. Laing, Wharton & Down, Limited, at their works in Haunch-of-Venison Yard, Brook Street, a few doors from New Bond Street, W., and may be viewed until January 28th, 1901, on which day tenders will be opened.

Germany.—The Elektro-Metallurgie Gesellschaft is the title of a new company which has just been formed in Berlin, with a capital of £5,000, to acquire and develop certain patents with regard to glycerine electrolytics for use in electro-metallurgical processes. The director of the new concern is Dr. Fritz von Liebermann, of Berlin.

Imports of Electrical Plant.—The imports of foreign electrical goods and apparatus into this country during last month amounted to £147,205 as compared with £149,537 in December, 1899. For the whole of the past year, the value of such imports is returned at £1,265,965.

Inquest.—On Friday morning an inquest was held at Charlton on the body of Peter Reid, aged 18 years, a machine minder, of 2, Coombe Villas, Westcombe Park, East Greenwich, an

employé at the D.P. Battery Company's works in Victoria Road, Charlton. The evidence showed that on Tuesday last the deceased went upon the platform above the fly-wheel of a dynamo and with a piece of wood tried to push the belting off the shafting on to a pulley. In doing so the deceased slipped and fell between the main driving belt and the fly-wheel and was crushed to death. He had been previously warned by the foreman not to go to the platform. The manager of the works, Mr. William Worthington, said that the fly-wheel in question made from 90 to 100 revolutions per minute. It was properly fenced by guards but the platform was not railed. He was of opinion that it was not dangerous work, but thought that it was [? not] advisable that a lad like the deceased should do it. The company now intended to have the platform railed. The jury, after a long inquiry, returned a verdict that the deceased died from injuries sustained whilst removing the belting from a shafting in motion, the platform being unprotected at the time.

Institution of Junior Engineers. — On Saturday, January 12th, a large party of members of this Institution visited the works of Messrs. W. T. Henley's Telegraph Works Company, at North Woolwich. They were received with every attention, the various processes in connection with the manufacture carried on being seen in operation, and fully explained by the members of the staff, under whose guidance the inspection was made.

Liquidations and Dissolutions.—At a meeting of Sax, Slatter & Co., Limited, held at Clerkenwell Road, on January 17th, a resolution was passed for winding up with Mr. A. A. Yeatman, of 2, Gresham Buildings, Basinghall Street, E.C., as liquidator.

Newcastle.—An important conference was held here on Monday between representatives of the Town Improvement Committee of the Corporation, and the officials of the Newcastle Electric Lighting Company, the Newcastle Electrical Supply Company, Newcastle Gas Company, Newcastle Water Company, National Telephone Company, and the Post Office authorities, to devise a scheme whereby the constant upheaval of the principal thoroughfares owing to the laying of new mains, repair work, &c., could be avoided. The proceedings were private, but we learn that pending a further conference the various companies decided as far as possible to obviate the disruption of traffic by directing their lines as far away from the chief traffic centres as could be arranged.

Press Guide.—The 28th annual issue of *Willing's Press Guide* (1s.) has been brought out. It is a handy-sized reference book giving an alphabetical list of all newspapers and periodicals issued in the United Kingdom. It gives such particulars as date of publication, price, name and address of publisher, details which are of interest to most commercial and many professional men. The publisher is J. Willing, jun., Limited, of 125, Strand.

Private Bills.—Attendance was again given at the Private Bill Office, Westminster Hall, last week, to receive any memorials that might be handed in alleging non-compliance with the Standing Orders in respect of any of the second hundred of the Bills on the general list of petitions. Memorials were deposited in respect of six Bills. In the case of the Metropolitan District Railway Bill the memorialists are Messrs. J. A. Macmillan and others. The memorialists in the case of the Charing Cross, Hammersmith, and District Electric Railway are Macdonald, Sinclair, and Co., Limited; and in the case of the Brompton and Piccadilly Circus Railway (Extensions) the memorial proceeds from Messrs. James Redler and Walter Ernest White. The other memorials presented have relation to the Harrogate Corporation, South Yorkshire Electric Power, and Scarborough Electric Tramways Bills.

Standard Fittings.—We have received from the Simplex Steel Conduit Company, Limited, of Birmingham, a small specimen table standard, which they have just brought out. It impresses one as being a first rate commercial sort of fitting, very suitable for ordinary desk or table use. In the firm's new catalogue, which is now in the press, some particulars of these serviceable standards are given.

ELECTRIC LIGHT AND POWER NOTES.

Abercarn.—Representatives of the Abercarn and Risca D.Cs. recently had a meeting, at which it was resolved that Messrs. Meadows & Lloyd, of Westminster, be engaged at a fee of 40 guineas to report upon the feasibility of a joint scheme for the electric lighting of the two districts, the other authorities in the valley having withdrawn from the proposed joint undertaking.

Alfreton.—The U.D.C. has applied to the B. of T. for a prov. order for its £13,500 electricity supply scheme. £1,000 is included for "free wiring."

Barnstaple.—The T.C. is considering an electric lighting scheme. An expert report shows that the undertaking can be carried out on a remunerative basis. Three schemes are treated in dtail. The one the expert favours provides for utilising water-power at Raleigh in conjunction with the use of either gas or steam-power. The cost of a water-power scheme with supplemental gas-power would be £26,350, and with supplemental steam-power £28,850. A steam plant scheme would cost £24,800, but owing to the greater cost of working, the profit is returned at a much less satisfactory figure, being estimated at only £104 for the first year, compared with £756 for the water-power and gas scheme. These calculations are based on the assumption that the old prison premises in Castle Street would be made the central station, where the steam or gas plant would be located. In some quarters in the town there is, according to a Plymouth paper, a strong feeling against the Raleigh scheme, as it is maintained that the water-power available is not sufficient to justify the large expenditure that would be involved. But the Council is sending a deputation to Taunton to inspect the electric lighting arrangements there.

Bradford.—On 18th inst. Mr. R. H. Bicknell, M.Inst.C.E., a L.G.B. inspector, held an inquiry into the proposal of the Corporation to borrow £140,000 for the extension of electric lighting facilities within the city.

Bristol.—The City Council on Tuesday considered a proposal from the Electrical Committee that the salary of Mr. Faraday Proctor, city electrical engineer, be raised from £400 to £600, with a further increase to £700 on January 1st, 1902, on condition that Mr. Proctor undertakes not to determine his engagement for two years from January 1st, 1901. This condition was accepted by the engineer. The proposal met with a small amount of opposition from several working men members, but was strongly supported by Alderman Pearson, who stated that although financially the Electrical Committee would not be flourishing for the next year or two—for they would have to meet the interest and sinking fund on new works, which during that period would be unremunerative—there was not the slightest chance of their making a call on the ratepayers under any possible circumstances. The revenue was increasing now at the rate of something like £7,000 to £8,000 a year, and they hoped to be able to bear the serious burden the Local Government Board had put upon them. The resolution granting the increase was carried.

Carnarvon.—At a meeting lately held at Carnarvon, the Gwyrfai D.C. considered the correspondence which has passed between Mr. Peterson, of London, and themselves relative to the proposed electricity works for Carnarvon and the neighbouring villages, and a light railway between Carnarvon and Dinas Dinlle. The D.C. decided to inform Mr. Peterson that his application would not be opposed, but that a clause would be introduced into the order making it inoperative unless the work were commenced within three years of a given date.

Chepstow.—A movement is on foot in Chepstow to lay down electric lighting plant.

Dewsbury.—Reductions have recently been made by the Corporation in the charge for electricity. The Brighton rebate system is still in force, but the time during which electricity is charged for at 6d. per unit is reduced from 1½ hours to 1 hour a day. The rebate price is 3½d. per unit. Meter rents have also been reduced. These modifications have led to an increased demand for the light. There are now 15,558 8-C.P. lamps in the borough, 2,530 having been added since last March.

Dorking.—The U.D.C. have filed a notice against the application for a P.O. by the County of Surrey Electrical Power Distribution Company, Limited, for lighting the district.

Dysart.—A proposal to introduce electric lighting throughout the burgh is under consideration. The T.C. is in favour of the introduction of the light as early as possible, but has agreed to obtain further information.

Eastbourne.—The T.C. met on 21st inst. to pass a resolution applying to the L.G.B. for power to borrow a further sum of £50,882, the amount required for the new electric light station at Roselands, for new transformers, plant, mains, and for the purpose of public arc lighting, &c., in accordance with the revised estimate prepared by Mr. Hawtayne. The amount of the original estimate passed by the Council was £33,412.

Glasgow.—The Council has decided to light Great Western Road with 7-ampere arc lamps. Fifty is the number required at present, but if the same system is adopted throughout its length some 200 may be required.

Greenock.—Mr. W. M. Nelson, the electrical engineer, reporting on the progress made by the electric light, gives the number of units generated for the four weeks ended December 28th as 38,334, of which 32,034 units were sold. As against the previous month this is an increase of 4,951 units generated and 3,895 sold. For the 55 weeks since its institution in the burgh 226,668 units have been generated and 150,642 sold. The applications for supply number 172, equivalent to 13,784 8-C.P. lamps.

Harrogate.—Colonel A. G. Durnford, R.E., held an inquiry last week respecting an application to borrow £10,000 for electric lighting purposes. The loan is required principally for new generating plant. Mr. G. Wilkinson, electrical engineer, explained the scheme, and Councillor Chippindale (chairman of the Electric Light Committee) referred to the necessity of the work, and the desirability of the sanction being obtained as early as possible.

Hendon.—The D.C. has written to the Hampstead Borough Council stating that it is about to carry out an electric lighting scheme, and asking the Hampstead Council if it can supply electrical energy to Hendon for a term of years in the meantime, and if so, on what terms. The letter has been referred to a committee.

Irvine (Ayrshire, N.B.).—The T.C. has decided to adopt electricity supply, and intends applying for the necessary powers. Mr. Bryson has been appointed consulting engineer.

Liverpool.—A scheme has been mooted for the substitution of electric for hydraulic haulage power on the vast area of quays and warehouses bordering the Mersey.

London.—ST. PANCRAS.—The Electricity Committee at a meeting of the Borough Council last week submitted a report, respecting the recent reference to consider the question of wiring and supplying electrical fittings to houses situated in streets where mains are already laid, such fittings to be provided for householders on the payment of an annual rent charge. It appeared that in 1893 the late Vestry asked the opinion of Mr. Fletcher Moulton, Q.C., on the question of supplying motors on the hire purchase system, and he advised that "the Vestry have no power to supply motors either on the hire purchase or any other system, and that beyond the supply of electricity they have no power to supply apparatus for its consumption." The Committee also drew attention to the decision last December of the L.G.B. auditor in the case of the Dublin Corporation, where members of the Electric Lighting Committee were surcharged in this respect to the extent of £2,000. Notwithstanding the learned opinion and the Dublin surcharge, the Electricity Committee expressed the desirability of being able to supply motors on the hire purchase system, as well as fittings for lighting and other purposes. The Council agreed that the best means of obtaining powers for these purposes would be to convene a conference of local authorities to discuss the subject with a view of promoting legislation. The Electricity Committee stated that Mr. S. W. Baynes, chief electrical engineer, had presented a report concerning the prospective demands for supply and the capacity of the existing plant to meet future requirements. The question as to the best means of utilising to the fullest extent the possible extensions of the present generating stations was under the consideration of the Committee, but they had come to the conclusion that when the stations were developed to their greatest capacity, a third station would be required to meet the increasing demand in the northern part of the borough. The Council sanctioned the making of inquiries for a site for a new station.

FULHAM.—A large section of the borough is now practically ready for the electric light to be turned on. Applications have been already received from private individuals equivalent to over 10,000 8-C.P. lamps.

Maidstone.—It has been decided that the charge for electrical energy for power and heating purposes shall be 2d. per Board of Trade unit, subject to the following rebates per quarter:—

			Per unit.
Over 1,000 and under	2,000	B.T.U.	$\frac{1}{10}$th.
„ 2,000 „	3,000	„	$\frac{2}{10}$ths.
„ 3,000 „	4,000	„	$\frac{3}{10}$ths.
„ 4,000 „	5,000	„	$\frac{4}{10}$ths.
„ 5,000 Board of Trade units			$\frac{1}{2}$d.

Minimum charge 1½d. per unit.

Sittingbourne.—Messrs. Stevens & Barker are to interview the D.C. on the electric lighting question.

Stroud. — The offer of Messrs. Medhurst & Lloyd, electrical engineers, of Westminster, to make a report as to the best scheme for lighting Stroud by electricity, and the provision of a refuse destructor, has been accepted by the Stroud Urban Council.

Sudbury.—The electric lighting scheme was approved last Friday by the T.C. in committee, and will come up for discussion in public on Monday, at a special meeting of the urban sanitary authority. The approximate cost is £20,000, the outlay for the electric lighting being estimated at about £16,300, and for the refuse destructor about £2,000. Mr. Hawtayne, the consulting electrical engineer, estimates that some 2,000 tons of refuse are annually collected, and assuming that, as the principal makers of destructors are now prepared to guarantee, 1 lb. of steam will be generated by every 1 lb. of refuse destroyed, and that about half the amount generated will be turned to useful work, a saving will be effected in the annual coal bill of the electric lighting undertaking of approximately £200 per annum—sufficient to cover interest and sinking fund charges on the extra cost of the destructor and leave a reasonable profit. In this scheme, it is pointed out, the sale of electricity for lighting only has been considered. A considerable demand for motive power may be reckoned upon, thus increasing the profit.

Surbiton.—The U.D.C. have received an estimate from Messrs. Hopkinson & Talbot for the erection and equipment of the Council's proposed electric lighting station, cables, &c., and have decided to apply to the L.G.B. for permission to borrow £50,000 to carry out the work.

ELECTRIC TRACTION NOTES.

Leicester.—An elaborate and comprehensive report on the systems of traction in various towns, and on electric tramways for Leicester, has been issued by the Tramways Sub-Committee of the Corporation. A large number of towns have been visited, both in this country and on the Continent, and the systems in use in these places are described, with excellent illustrations. The report is not confined to electric traction, the Edinburgh cable tramways and the Paris compressed air system being included. Naturally, and inevitably, the sub-committee reports emphatically in favour of the trolley system. "There is no tramway company whose representatives we have interviewed abroad which would not, if allowed, have adopted the 'overhead' system throughout in preference to any other." The conduit is judicially considered, but is put out of court by its great cost, both in capital outlay and running expenses. The Diatto surface-contact system at Paris was inspected, but failed to convince the sub-committee, which concluded that "it would in construction, working and maintenance be much more expensive than the 'overhead trolley' system." The accumulator system has "signally failed" to give satisfaction, and is about to be abandoned both in Vienna and Berlin; the cable and compressed air are considered unsuitable for use in Leicester. Finally, the report recommends that the trolley system be adopted, and that the existing tramlines be reconstructed, a total route length of 20¾ miles being scheduled; and that a central electric traction power station be erected, using the direct current system, under the advice of a consulting engineer of considerable experience in electric traction. The whole of the structural work will be designed and carried out by the borough surveyor, Mr. E. G. Mawbey, M.Inst.C.E., and a resident electrical engineer will be appointed to take charge of the power station and all the electrical equipments, under the direction of the Tramway Committee. There is no intention to work in conjunction with the existing Electricity Committee in any way. An interesting summary of the information obtained from other British towns is appended to the report.

Barnes.—At a special meeting of the U.D.C. on Friday, it was decided to oppose the tramway scheme of the L.U.T., as to line No. 1 on the ground that the route (across the Common) is not satisfactory, and as to No. 9, unless the company undertake to widen Upper Richmond Road. The Council also decided to lodge a petition against the Bill; to communicate with the Surrey County Council to the same end; and to endeavour to induce the company to take current from the Council's electricity works.

Belgium.—The project of the Brussels Metropolitan Railway, which has for its object the connection of the two principal railway termini of Brussels, as much as providing a frequent service of city trains, is an electrical undertaking of much more importance than might seem at first glance. It is, in reality, the first step in an ambitious scheme which aims at the transformation of the principal sections of the Belgian State Railway system into electrically worked lines. The *Tramway World* says that the project has now passed through the preliminary stages, and only awaits the completion of formalities before the works are commenced.

Birkenhead.—The points at the New Ferry car shed have been laid, and the line from Woodside (Birkenhead) to New Ferry is now awaiting the B. of T. inspection. Four electric cars have been delivered to the Corporation, and two more have been finished by the builders, Messrs. Milnes, of Birkenhead. Trial runs have already been made over the length of line named.

Blackpool.—On 21st inst. Mr. A. P. Trotter held an inquiry with reference to the application of the Council for the sanction of the B. of T. to the borrowing of over £82,000, for the construction and electrical equipment of new tramways round the district of Marton. There was no opposition. The tramways cover about two miles, and are expected to be ready for the season.

Bournemouth.—The Board of Trade have sanctioned the borrowing of nearly £200,000 for the construction of tramways by the municipal authorities.

Chadderton.—The D.C. has decided to accept the terms of the Manchester Corporation to construct a certain length of tramway within the district. Two-fifths of the proposed line will be in Chadderton, and the other three-fifths in Middleton. Middleton T.C. has also accepted Manchester's terms.

France.—In Paris, on the evening of the 7th inst., a fall of snow was experienced. No sooner was salt distributed over the track of the Thomson-Houston electric tramway conduit line, in order to melt the snow, than the cars came to a stop. *La Nature* states that the cause of the stoppage was found to be that the channels, in which a sliding block attached to the cars picks up the current, quickly became nearly full of salt water. The water had been brushed into the channels by the electric track sweeper; salt water being a good conductor, a loss of current took place in the channels, the whole length of the conductors, sufficient to bring the cars to a stand. Ordinary water has not this effect. Naturally steps were quickly taken to remove the salt water from the channels.

Liverpool.—At a meeting of the Watch Committee of the Liverpool City Council on Monday, some discussion took place respecting the frequent accidents in connection with the working of the extensive electrical tramway system in the city. A resolution was passed asking the Electric Power and Lighting Committee to request the engineer to issue clear instructions, so that the police or tramway employés might know how to deal with electric wires in the event of their falling into the streets.

Liverpool and Manchester Express.—On Thursday of last week representatives of the Irlam District Council and the promoters of the Manchester and Liverpool Electric Express Railway Bill, met in Manchester to confer on points of opposition by the Council with a view to the opposition to the scheme being withdrawn. A new Bill has been drafted, in which alterations have been made which, it is hoped, will meet the views of the Irlam Council. No road deviations are proposed to be made in the Council's district in the Bill. The Council, however, ask for skew bridges at the road crossings, and for a 36 feet wide road instead of

30 feet. They also ask that the gradients shall be reduced from 1 in 40 to 1 in 50. The promoters explained to the Council that the cost of making these alterations would be great, and asked for a reconsideration by the Council. The matter has now to be reported upon to the Irlam District Council for decision.

The Parliamentary Committee of the Liverpool Corporation has resolved, two members dissenting, to oppose the Liverpool and Manchester Electric Express Bill. The Committee think that as the railway will enter the city on the overhead system at a considerable elevation, it will be unsightly.

Leeds.—The Tramways Committee recommends the Council to increase the salary of Mr. John Burbridge, the chief electrical engineer, from £400 to £600.

Leith.—Last week the General Committee of the Town Council considered a letter from the lessees of the Leith Tramways line, regarding the proposed introduction of electric cars. The letter stated that the lessees would desire to own the undertaking for at least 21 years from June, 1906, and that the price of the motive power to be applied by the Corporation should not exceed 1½d. per unit. The Committee decided to inform the company that they would be prepared to recommend the Council to entertain an extension of the duration of the company's ownership in order that the Leith tramways might be worked by electric traction, provided the company could arrange to carry the electric traction to Princes Street.

Metropolitan Railways.—The following article appeared recently in the *Daily Telegraph* from its correspondent in Vienna:—

"In view of the intention of the directors of the London District and Metropolitan Railways to substitute electric traction for steam locomotives on their line, some account of the electric system installed by Messrs. Ganz & Co. at Buda-Pesth may be of interest, because, in the view of many distinguished specialists in this branch of engineering, the method in question seems calculated to effect a complete revolution in railway working. On behalf of the English companies referred to, Buda-Pesth will, it is understood, be visited this week by experts, who will examine the system with a view to its possible adoption in London.

"Up to the present electric railways have for the most part, in Europe at all events, been operated by direct current at a pressure of 500 volts or so. But Messrs. Ganz use the three-phase alternating system at the high working pressure of 3,000 to 5,000 volts. In this way it becomes possible to carry on very long lines. For a long time the three-phase system has been the dream of electricians, but hitherto it has been found extremely difficult, if not impossible, to design and make transformers which shall reduce the pressure of 20,000 volts with which the special trolley wires are charged down to 3,000 or 5,000 volts. The latter current is conducted to the three-phase motors on the locomotives by a trolley. The trolley line consists of two copper wires, each only eight millimetres (·315 inch) thick, the third conductor being the rails themselves. The trolley arm and carriage comprises a wooden shaft or arm, upon which are placed two insulated copper cylinders, by which the current is passed through two contact wires. The high-pressure conductors are entirely inaccessible. A full technical description of the apparatus would hardly be intelligible without the aid of drawings; but, briefly, it may be said that the insulated wires, which are encased in metal tubes, are connected to the steel frame of the locomotive in such a way as to preclude the possibility of accident.

"Special attention is paid to the signal question. In consequence of the high voltage at which the line is worked, the volume of current is relatively small, and it is, therefore, feasible to combine the conductors with the sections of the block system, and careful arrangements are made for safety, whereby, in the event of a wire breaking, or the contact mechanism failing to act, the current is cut out, and the brakes applied to the train automatically.

"The inventors of the system claim for it extraordinary simplicity. Hitherto, in cases where three-phase alternating current has been installed, it is first carried from the central generating station to the transformer station, where it is converted to direct current at the lower pressure of 500 volts. But under this arrangement very large copper conductors must be used; whereas, the Ganz system requires only thin wires, causing a great difference in the cost of construction, an economy which is also apparent in the working of the line, as sub-stations are not wanted, the transformers actually used needing no supervision.

"With regard to the ventilation of the Buda-Pesth line, there is practically no difference as compared with other railways, and the air is always pure.

"The system was first installed on the Valtellina line, belonging to the Italian Mediterranean Company, where it is seen to great advantage. This railway runs, *viâ* Lecco, Sondrio, and Colico, to Lake Como, where motive power for the dynamos is obtained from the River Adda to the extent of 6,000 H.P. From the central station the wires, charged with a three-phase current of 20,000 volts, proceed to 10 converter stations, each of 300 K.W. capacity, where the voltage is reduced from 20,000 to 3,000, the current being then led direct to the carriages. The wires carrying 20,000 volts are only 7 millimetres (·275 inch) in diameter, the trolley wires being 8 millimetres (·315 inch) thick. The latter are placed at a height of about 20 feet above the rails. Between Lecco and Sondrio there are 30 tunnels, of an average length of about 700 yards, and the fouling of the air by the smoke forced the company to abandon steam locomotives in favour of electric traction. The passenger vehicles in use on the line are elegantly appointed motor cars, each some 50 feet long, and each equipped with four three-phase motors of 150 H.P. These coaches weigh 50 tons apiece, and carry 60 persons, and to each motor car are attached four trailers of equal size. The goods cars are also equipped with four motors, and are capable of drawing 250 tons at 30 kilometres (18 miles) an hour. The passenger cars are calculated to attain a speed of 36 miles an hour on the level, and 18 miles an hour on gradients of 10 in 1,000.

"The firm of Messrs Ganz & Co. constructed the experimental railway at Buda-Pesth at their own expense. This is two kilometres (about a mile and a quarter) long, and has now been worked for a year with complete success. Although only a short one, the line demonstrates fully the simplicity and safety of the system, and is the subject of deep interest to electricians, many of whom arrive every week from abroad to study it."

Middleton.—The T.C. has decided to apply for borrowing powers for £37,500 for tramway purposes, and to the Local Government Board for £5,000 for street widening.

Newcastle-on-Tyne.—Despite many natural difficulties, the contractors for the Newcastle electric cars are making fair headway, though (says our local correspondent) some of the "City Fathers," who know as much about laying a line as the man in the moon, have made themselves conspicuous recently by allegations of delay.

Richmond (Surrey).—As a further means of opposing the scheme of the L.U.T. Company, the Richmond T.C. is about to consider proposals on the part of the Richmond Electric Light and Power Company to promote a tramway scheme for Richmond, Barnes and Mortlake, in conjunction with the local authorities, who would have the right to purchase the undertaking. The promoters are willing to construct what lines the authorities think may meet the needs of the districts, and are prepared to take over the existing line from Richmond to Kew as soon as it shall fall into the hands of the T.C. a few years hence.

Saddleworth.—The D.C. are contemplating the promotion of an electric lighting and traction scheme for the district. They have invited Springhead D.C., who have also had under consideration a similar project, to meet them to consider how the two schemes might usefully communicate at certain boundary points.

Underground Railways.—The Victoria, City and Southern Electric Railway Bill came before the examiners of Private Bills in the House of Commons on Monday, and there being no appearance, the Bill was marked "dead." The railway was to have run from St. George's, Hanover Square, to Cannon Street, and thence to Peckham.

Wigan.—The new line of electric tramway between Wigan and Martland Mill Bridge, Lancashire, has been inspected by Major Dreuit, R.E., of the Board of Trade. The length of line inspected has cost about £14,000. The whole of the tramway scheme in the Wigan district will involve an outlay of about £150,000.

TELEGRAPH AND TELEPHONE NOTES.

Australian Cable Rates.—The Eastern Extension, Australasia and China Telegraph Company, Limited, announces that the Government of New South Wales has now accepted the agreement entered into last year by the Governments of South Australia, Western Australia, and Tasmania, with the Eastern companies for establishing an alternative cable to Australia *viâ* South Africa. Consequently the reduced rates recently announced for telegrams exchanged with South Australia, Western Australia, and Tasmania, namely:—3s. 6d. per word for ordinary messages, 2s. 6d. per word for Government messages, and 1s. 4d. per word for Press messages, will be applicable to telegrams exchanged with New South Wales on and after the 1st prox. Telegrams for Victoria, Queensland and New Zealand will continue to be charged at the old rates.

The Committee on Telegraphs.—At the autumn meeting of the Association of Chambers of Commerce the Government were urged to promote an inquiry into Imperial telegraphic communication, and, in reply, the announcement is made that "the Government has decided to appoint an Interdepartmental Committee on the system of cable telegraphs of the Empire, consisting of Lord Balfour of Burleigh (chairman), the Marquis of Londonderry, the Right Hon. R. W. Hanbury, the Earl of Hardwicke, the Earl of Onslow, Major-General Sir J. C. Ardagh, and Rear-Admiral R. N. Custance. The terms of reference to the committee are as follows: To inquire into the present system of telegraphic communication between different parts of the Empire, and to consider in what respects it requires to be supplemented. To investigate the relations between private cable companies and the Imperial and Colonial Governments (including the Government of India), the amount of control exercised by these Governments, and the policy which should be pursued by them in future, especially when new concessions are sought. To examine existing rates, to report how far they are fair and reasonable, and, if not, how any reduction should be effected."

Hartlepool Telephones.—The Hartlepool Town Council has decided to approach West Hartlepool with a view to a joint application being made for a license to establish a municipal telephone exchange.

(*Continued on page* 157.)

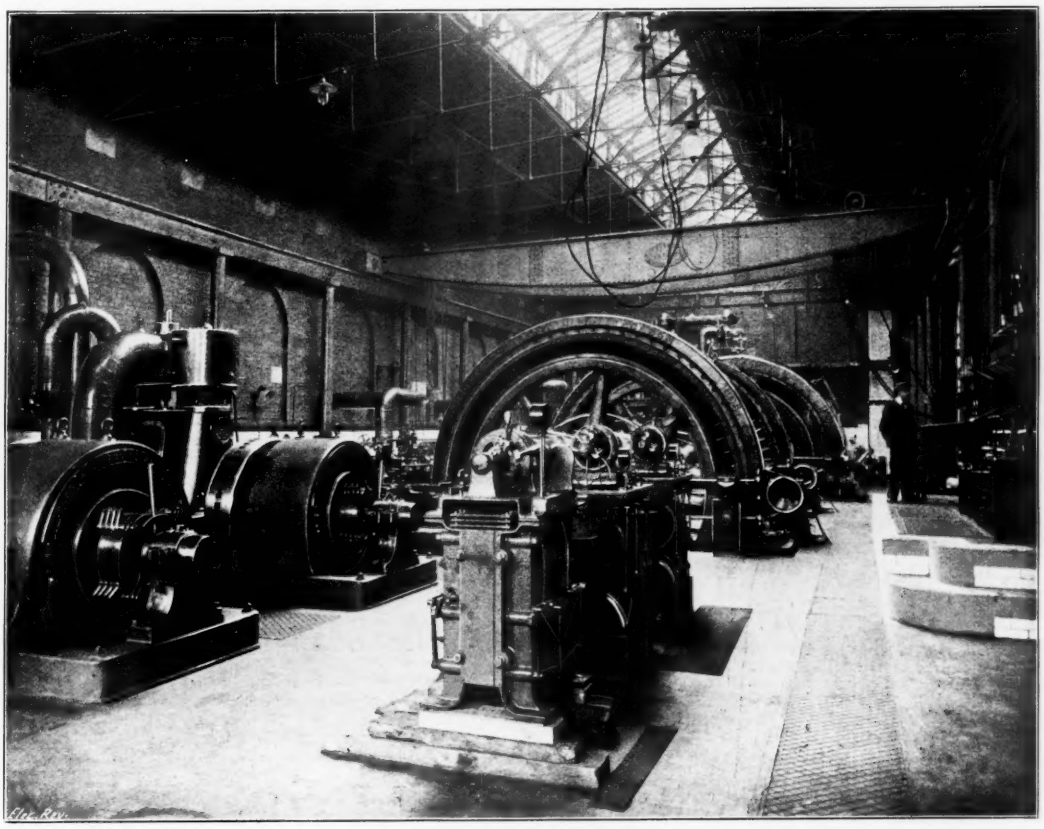
SOUTHPORT ELECTRICITY WORKS AND TRAMWAYS.

The attractions of Southport to visitors are many and varied; it is, as our readers are doubtless aware, a picturesque seaside watering-place within easy distance of Liverpool and Manchester, held in high esteem as a winter health resort, and is very largely residential in character. It is also distinguished by being, next to Tunbridge Wells, the richest township for its size in the kingdom. It is not to be wondered at, therefore, that the supply of electricity in Southport is a flourishing industry, and that extensions of the first magnitude are being made to the electricity works.

The supply of electricity by the Corporation was begun in November, 1894, with a connection of 5,031 8-c.p. lamps—a number considerably in excess, even then, of the capacity of the station. The high pressure alternating current system, with sub-stations, was used, in accordance with a scheme drawn up by Mr. G. Wilkinson, and at a cost of £13,000. The alternators originally installed were rope-driven, and had a total output of 125 kw.; the station, as then constituted, was described in our issue of November 9th, 1894. Mr. Arthur Ellis was then the borough electrical engineer.

Important extensions were made in the following year, when two 125-kw. Ferranti fly-wheel alternators, direct-driven by Musgrave horizontal engines, and two 40-lamp rectifiers, were installed; these were described in the Electrical Review for November 1st, 1895. The capital expenditure then totalled about £43,500, and the whole of the extensions were carried out under the direction of Mr. Arthur Ellis.

In the following year Mr. Ellis accepted an appointment at Bolton, and Mr. C. D. Taite was appointed in his place. Since then the old rope-driven sets have been removed, and other extensions have followed from time to time, bringing up the present capacity of the station to 1,150 kw. for lighting purposes, while additional plant of 600 kw. capacity has been or is being installed for the supply of energy to the tramways. The original building will hold no more machinery, but so urgent is the demand for electricity that the Corporation has found it necessary to build what is practically an entirely new station, abutting on the old one, and providing accommodation for generating plant of 3,000 kw. capacity, in units of 600 kw. each. In describing the details of the system, we shall confine ourselves chiefly to those features which we have not previously dealt with in the Electrical Review.

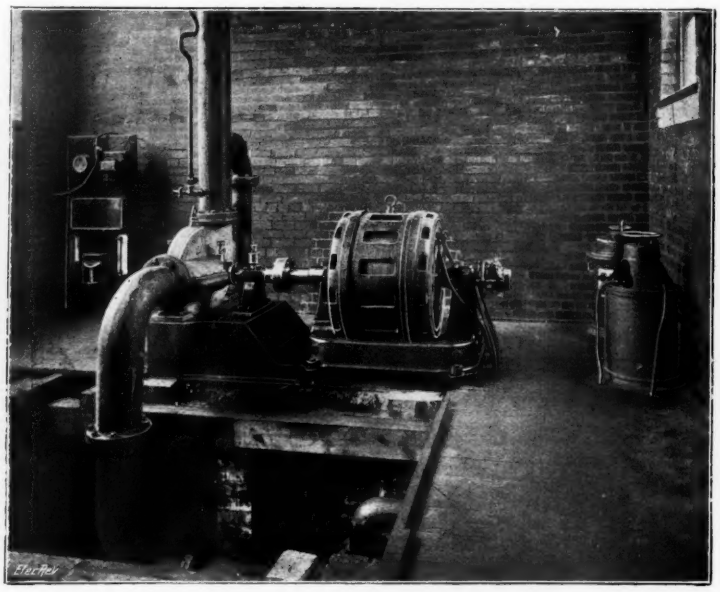


General View of Engine Room.

The boiler plant in the old station consists of six Lancashire boilers, each 28 feet long and 7 feet in diameter; of these, two were made by the Oldham Boiler Company and four by Messrs. Tinker, Shenton & Co. All of them have been fitted with superheaters by Messrs. John Musgrave and Sons, Limited, of Bolton, with the result that a remarkable reduction in the coal bill has been effected. In the course of an 8 hours' test the use of the superheaters was found to effect an economy of 17 per cent., both in the coal and the water consumed. The pressure at the engine was 135 lbs., corresponding with a temperature (saturated steam) of 358° F.; the temperature of the steam as it left the superheaters was 476° F., showing a possible superheat of 118°. The boilers are hand fired, and work at a pressure of 140 lbs. per square inch. In the new boiler house three

Musgrave Lancashire boilers have been installed, each 8½ feet in diameter and 30 feet long. These are built for a pressure of 200 lbs. per square inch, and are also provided with superheaters. There is room for four more boilers of the same size. Hopkinson boiler fittings and valves and Geipel steam traps are used throughout.

The steam range in the boiler house consists of a single main pipe, connected to the boilers both through the superheaters and direct. Branches are taken from this pipe through the wall to the respective engines. A special feature of the piping is the number of large bends which occur at intervals, in the main pipe as well as in the branches; the result is a remarkable freedom from leaky joints. The new boilers are connected with the older ones through a stop valve. The whole of the steam-piping is of lap-welded steel, and was put in by Messrs. Babcock and Wilcox; it is covered with silica cotton and cased in sheet steel, which gives a very good and durable finish.

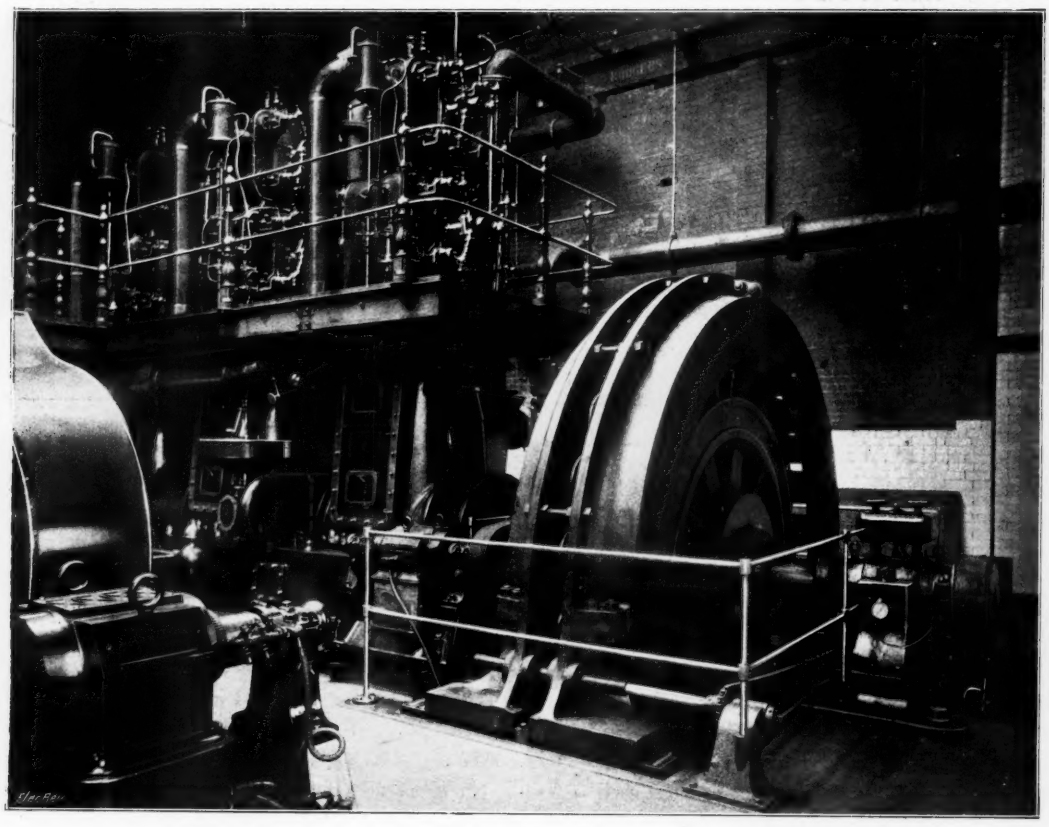


Gwynne Centrifugal Pump driven by Wenström Induction Motor.

There are two economisers, one of 288, and one of 360 pipes, both made by Messrs. Roberts; the scrapers are driven by a Langdon-Davies single-phase induction motor of 3 B.H.P. The chimney is 210 feet high and 7 feet 6 inches in diameter.

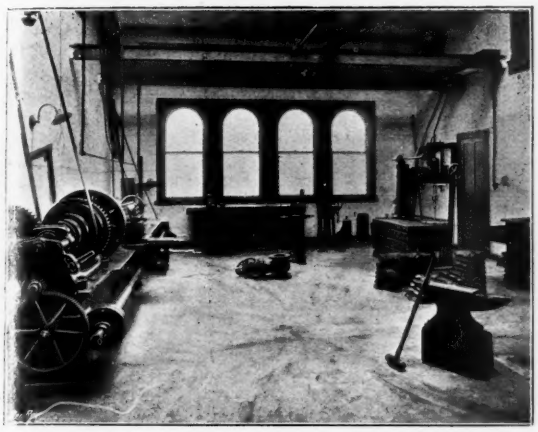
Coal is brought to the station in railway trucks from the L. & Y. Railway, and is dropped into bunkers outside the boiler-house wall, from which it is pitched on to the stoking floor. The price of the coal, which appears to be of good quality, has risen by no less than 130 per cent. in the last two years.

Feed water is derived from a reservoir, which is filled from a stream by means of a pump; the town supply is used as a stand-by. There are two feed pumps, of Messrs. J. & G. Weir's make, each capable of delivering 6,000 gallons per hour at boiler pressure, sufficient to supply six boilers of the new type; there are also a Worthington and a Cameron pump, belonging to the original installation. The feed-water piping is in duplicate throughout. The water is passed through a feed-water heater, which receives the exhaust from the feed pumps, to take the chill off it before entering the economiser; by this means much of the corrosion commonly met with where cold water is used is avoided.



Ferranti Alternator and 1,000-H.P. Musgrave Engine.

The station is built upon very treacherous ground, consisting of layers of sand, peat, and soft clay, beneath which is a deep quicksand. The old engine room was founded on 18 inches of concrete laid over the clay, but this has been found to be too little, and for the foundations of the new station no less than 5 feet of concrete, with steel rings embedded in its substance, has been thought necessary. The plant at present installed for lighting consists of two Ferranti fly-wheel alternators of 125 KW. each, and one of 300 KW., all driven by horizontal Corliss-Musgrave compound engines at 96 revolutions per minute; the first two of these have already been described, and the third is of similar construction, as shown in the illustration below. The remaining lighting set consists of a Ferranti alternator of the "copper" type, of 600 KW., driven by a vertical high speed compound engine with direct-driven Corliss valve gear, made by Messrs. Musgrave & Sons, Limited. The alternator is of Messrs. Ferranti's standard pattern, with 28 coils and poles, and has given entire satisfaction throughout, running perfectly in parallel with the iron-cored alternators in spite of the extreme difference in speed and type. The engine, however, is, we believe, entirely novel. It is of the three-crank tandem type, and runs at the high speed of 214 revolutions per minute. Practically there are three compound engines coupled together, all parts being interchangeable, so that if any part, such as, for example, one of the three sections of the crankshaft, breaks down, another can be used in its place, and two engines run until repairs are effected.



Workshop.

The high pressure cylinders are 13 inches, and the low pressure 25 inches in diameter, with a stroke of 20 inches. Four double ported Corliss valves are fitted to each cylinder, worked by wrist plates, which ensures that the valves shall open quickly. Each valve is made adjustable and independent, two eccentrics being used for each engine, so that the steam and exhaust valves can be separately adjusted.

All three engines are controlled by one governor of the fly-ball type, worked by a Hans Reynolds chain from the crankshaft. The governor is coupled to three throttle valves, which are fixed close to the high pressure cylinders, so as to ensure that there shall be as little steam as possible included between them and the cylinders, an essential feature for close governing.

The engines are lubricated by means of Messrs. Musgrave's improved system of forced lubrication, oil being pumped to the working surfaces by means of four force pumps worked from the crankshaft; these pumps are so arranged that if one of them fails the others can be made to do duty for the faulty one. The engines are cased in so that the oil cannot be thrown out, but is all drained to a sump, and used over again after being cleaned.

Each engine is coupled to a Körting ejector condenser, maintaining a very high vacuum.

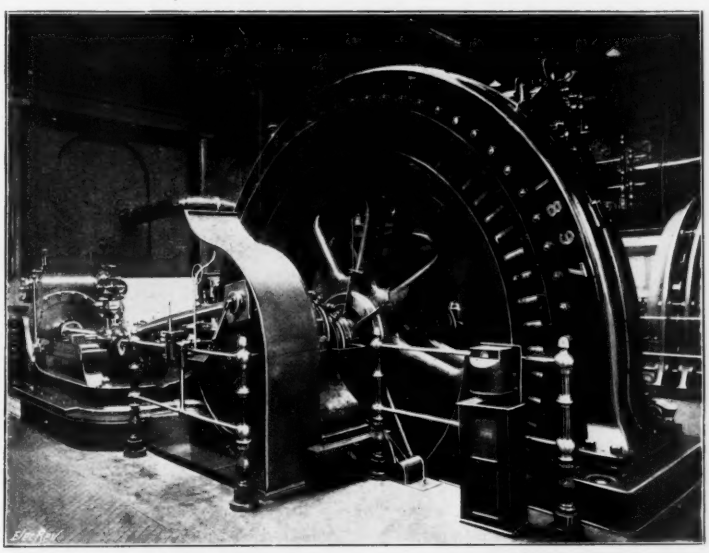
We were fortunate in seeing this engine running on load; it was most interesting, considering the high speed and large output. The set ran very quietly, and has, we understand, given every satisfaction.

The new engine room is 94 feet long, 60 feet wide, and 25 feet high to the top of the traveller rails; the floor will be 3 feet higher than the old floor level, on account of the deeper concrete foundation. The overhead traveller, by Messrs. Royce, is capable of lifting 15 tons, and is electrically operated from the traction generators; railway wagons can be run in beneath the crane, affording an immense economy and convenience in handling new machinery. While it takes half an hour to traverse the hand crane in the old building from one end of the room to the other, the electric crane can be worked from end to end in one minute.

The first set to be installed in the new engine room will be a Ferranti 600-KW. alternator, driven by a Belliss triple-expansion engine, guaranteed to take only 14·25 lbs. steam per I.H.P.-hour at full load, and 14·68 lbs. at half load.

A large cooling pond, containing 1,000,000 gallons, has been built near the station, to provide boiler feed water and condensing water; oil and grease are cleared out by periodically overfilling the reservoir and running off the scum.

Much use is made of single-phase induction motors; one of these, of the Fuller-Wenström pattern, is coupled direct to a Gwynne centrifugal pump, as shown in one of our views. The rated output of the motor is 35 B.H.P., but it has done twice this amount without the least injury. The combination runs quite quietly, and has given great satisfaction. The pump, which lifts 66,000 gallons 40 feet per hour, is used for raising water from the cooling pond to a tank, from which it flows to the Körting condensers. Another, of equal size, is shortly to be put down, and two smaller ones.



Ferranti Fly-wheel Alternator of 300-KW., and Musgrave Engine.

The workshop is driven by a Heyland motor of 6 B.H.P.; it contains a large lathe and a drilling machine, which are found to be invaluable to the undertaking; there are also various smaller tools.

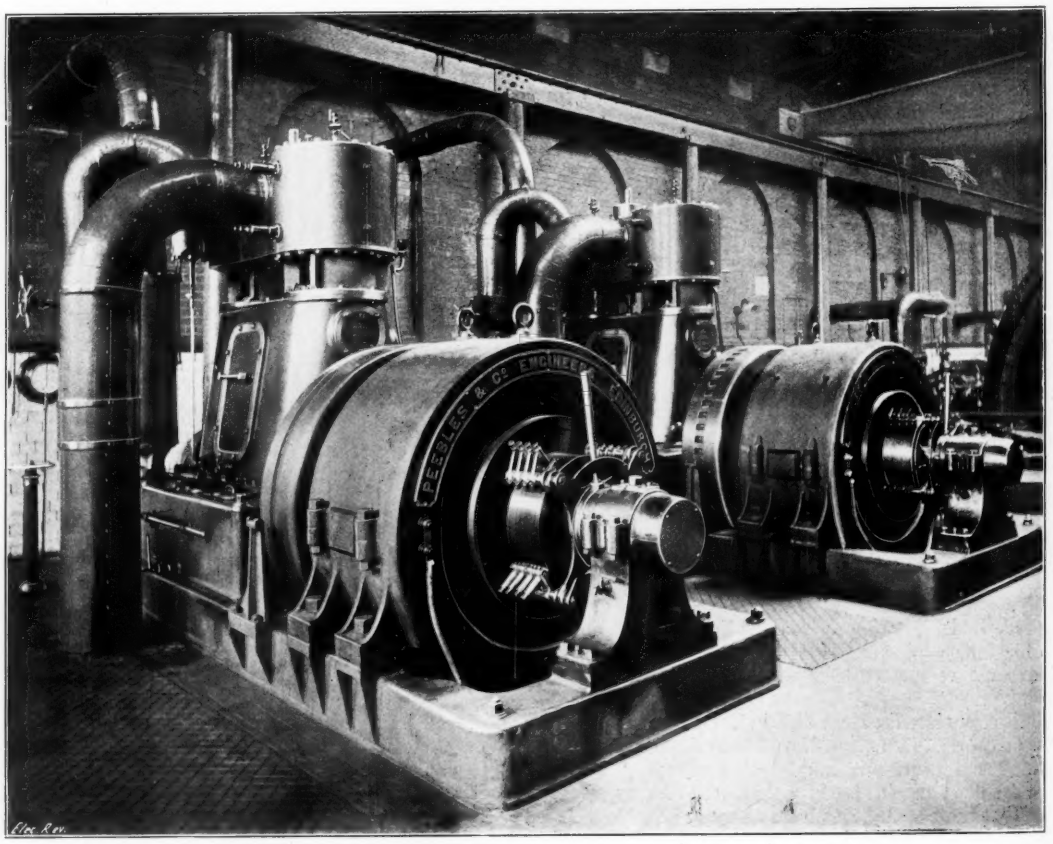
A large jet condensing plant and a three-throw Edwards air-pump have recently been installed in the old boiler house, driven by a vertical tandem compound engine of 24 H.P. at 100 revolutions per minute. The rated capacity of this pump is 22,000 lbs. of water per hour, and it maintains an excel-

lent vacuum—over 29 inches by gauge at the time of our visit—while working almost noiselessly. It consists of three vertical single-acting pumps of 24-inch bore × 10-inch stroke, and is mounted on a cast-iron base-plate extended to carry the engine. The buckets are worked by rods attached to an overhead beam, actuated by a crankshaft, which is supported by bearings between the pumps. This set, as well as an older one of 15,000 lbs. per hour capacity, was made by Messrs. Browett, Lindley & Co.

The lighting switchboard, which has replaced the one originally installed, is of Messrs. Ferranti's standard pattern, and provides for six circuits in addition to the alternators. Ferranti edgewise ammeters (which were first used here, we believe) and rheostats and Kelvin voltmeters are employed. A separate board is provided for the pilot circuits, with Kelvin multicellular voltmeters and a recording voltmeter. All the feeders are run direct to a main distributing sub-station, where they are parallelled through Ferranti fuses on a common bus bar. From this sub-feeders are taken to eight sub-stations, each of which again is coupled in a triangle with two of the others. Street transformers are used only for developing new districts.

Main Switchboards for Alternating Current.

Distribution is effected on the two-wire system by means of five separate networks, which are, however, connected in some cases by fuses in disconnecting boxes; the latter, of the Siemens and B.I.W. types, are also used at intervals of 150 to 200 yards in the distributors. All the high pressure cables are of the B.I.W. armoured type, laid direct; the low pressure cables are partly Siemens, jute insulated, and partly B.I.W., with paper insulation, and are armoured and laid direct in the ground. Southport is fortunate in having a sandy subsoil, so that picks are not used in street work, and accidents to insulation are rare.



Peebles Tramway Generators and Belliss Engines.

In the older sub-stations, Siemens and Johnson & Phillips

transformers are used, of 20 and 30 KW.; the later ones are of Messrs. Ferranti's make, the standard size being 30 KW., and provision is made for using them to give either 100 or 200 volts. Both pressures are in use, the choice depending on the density of the demand.

Two of the rectifiers are of several years' standing; the third is of Messrs. Ferranti's latest pattern, and embodies various improvements. The constant current transformer has been modified so that the coils run on ball slides, and one of them is tapped to feed the synchronous motor. Again, the field of the latter is made movable, so that the brushes of the rectifier need not be shifted, the field being rotated instead to adjust the sparking. At present the arc lamps are all in series; they are of the Crompton 15-ampere type, 42 in number. An extension of 25 lamps of the Brockie-Pell type is in hand; when this is completed the arcs will run on two circuits.

There are now 880 consumers, with 53,400 8-C.P. lamps; the population is 52,000. The charges for supply are based on the Wright system, with demand indicators, the prices being, for lighting, 6d. per unit for the first hour, 4d. for the second, and 2d. for the third; for power and heating the price is 4d. per unit for the first hour, and 2d. afterwards. As many of the consumers are very wealthy, electrical heating is unusually popular in Southport. The average price obtained last year was 4·10d. for lighting.

So far the maximum load has been 380 amperes at 2,100 volts, and the maximum output for one day 7,700 units, exclusive of the traction load.

For arcs, the charge is £20 per annum per 15-ampere lamp, representing 1·65d. per unit net.

So far we have not touched the tramways. These are in course of development and acquisition, some of the lines being still partly under the control of the tramway company; but six miles of track, of which two miles are double, are now electrically equipped, and by the end of the year there will be 8½ miles single and 3¾ miles double track.

The generating plant, shown on the previous page, consists of two four-pole generators, by Messrs. Bruce Peebles & Co., driven by two-crank compound engines made by Messrs. Belliss & Morcom. A third set is on order. The output of each is 200 KW., 380 amperes at 530 volts, at 360 revolutions per minute, but they are capable of withstanding overloads of 25 per cent. for short periods. The machines are compound-wound to rise from 500 volts at light load to 530 volts at full load.

The engines are of the Belliss standard type, with heavy fly-wheel, and run quite silently and steadily. They exhaust to the jet condensers already referred to, and made by Messrs. Browett, Lindley & Co.

(*To be concluded.*)

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 152.)

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
AFRICAN—St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
SOUTH AMERICAN—Pará-Maranham	March 1, 1900	
Pernambuco-Ceara	Nov. 29, 1900	
Cayenne-Pinheiro	Nov. 26, 1900	
Payta and Barranco	Jan. 7, 1901	
Falmouth-Bilbao	Dec. 28, 1900	
Latakia-Cyprus	June 20, 1899	
Marseilles-Barcelona	Jan. 7, 1901	
Havre-Waterville	Jan. 19, 1901	
LANDLINES:—		
SOUTH AMERICAN—Interior of Colombia landlines	Nov. 19, 1900	
Ecuador landlines	March 3, 1897	
Landlines west of Barquisineto and Coro	Nov. 1, 1900	
Barcelona (Venezuela)-Ciudad (Bolivar)	Nov. 1, 1900	
Communication with Carthagena and Baranquilla	Dec. 8, 1900	
WEST INDIAN—Landlines to Baracoa, Guantago and Sagua de Tanamo	Nov. 12, 1900	
Landlines between Puerto Plata and San Domingo City	Nov. 20, 1900	
CHINESE—Tientsin-Pekin	June 11, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 30, 1900	
Tientsin, *vid* Shanghai	June 16, 1900	
Tientsin and Taku *vid* Helampo	June 18, 1900	
Shanghai-Foochow	Jan. 16, 1901	
Shanghai-Amoy	Jan. 18, 1901	
All lines connecting Cochin China with Thuanan	Oct. 23, 1900	
Communication between Saigon and North Annam and Tonkin	Oct. 23, 1900	
Communication "*vid* Hanekine" interrupted on Persian territory	Feb. 26, 1900	
Majunga-Tananarive	Jan. 21, 1901	Jan. 23, 1901

Underground Telegraphs.—The Glasgow Chamber of Commerce has passed a resolution: "That the Chamber asks the co-operation of the other Chambers of Commerce in the United Kingdom, and the various Stock Exchanges, in petitioning the Post Office to establish a complete system of underground telegraph wires."

Norwich Telephones.—The Town Clerk reported to the T.C. last week that the Norwich Mutual Telephone Company having complied with the resolution of July 3rd last, the agreement, as amended, has been sealed by the company, and a copy forwarded to the Postmaster-General with a request that he will grant the company a license to provide telephone accommodation in the Norwich Exchange area.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—February 8th. The E.L. Committee wants tenders for surface condensers, air and circulating pumps. See "Official Notices" January 11th.

Aberdeen.—February 13th. The Tramways Committee wants tenders for electrical equipment of the Bathing Station route, comprising overhead material and underground cables. Poles provided by Corporation. See "Official Notices" January 18th.

Amsterdam (Holland).—April 1st. The Communal Council will on this date consider tenders for the supply and erection of all the motors necessary, and the installation of the electric lighting of the power station, switchboards, &c. Conditions from the Municipal Printing Office, 10 florins (8s. 4d.). Information from the manager of the office of Electricity, Achterburgwal, 213, Amsterdam.

Beckenham.—February 25th. The U.D.C. wants tenders for boilers, steam alternator, and combined engine, dynamo and motor set, pipework, batteries and switchboard for electricity works extensions. See "Official Notices" to-day.

Batley.—February 9th. The Corporation wants tenders for three high speed triple-expansion steam dynamos, one balancer, and one motor-generator. See "Official Notices" January 11th.

Battersea.—February 1st. Tenders are wanted for ordinary and prepayment electricity meters. Consulting engineers, Messrs. Kennedy & Jenkin.

Belgium.—February 6th. The municipal authorities of Seraing near Liege are again inviting tenders until February 6th for the concession for the construction and working of an electric tramway between Val-St.-Lambert and La Chatqueue. Particulars may be obtained from the Bureaux des Travaux, while tenders are to be sent to La Maison Communale Seraing, Belgium.

Bournemouth.—March 2nd. The T.C. invites tenders for 42 electric cars. See "Official Notices" January 11th.

Bournemouth.—March 4th. The T.C. wants tenders for three steam dynamos, and two steam-driven surface condensers. See "Official Notices" January 18th.

Bradford.—February 2nd. The Tramways Committee invites tenders for overhead equipment for 5 miles of tramway. Particulars, &c., at the Surveyor's office Town Hall, on payment of £3, returnable as usual.

Brighton.—January 28th. The Council wants tenders for three direct coupled compound-wound steam dynamos (Willans engines), tramway switchboard and negative booster for the North Road electricity works. See "Official Notices" January 11th.

Brighton.—February 14th. The Council wants tenders for overhead trolley construction, and equipment of routes; also for feeder, distributing, test and telephone cables. See two "Official Notices" January 18th.

Bristol.—January 29th. The Electrical Committee wants tenders for coal conveying, elevating and discharging machinery. See "Official Notices" to-day.

Burnley.—February 7th. The Corporation wants tenders for the supply of a traction switchboard. See "Official Notices" January 18th.

Canterbury.—January 30th. The Lighting Committee wants tenders for Lancashire boiler, 300-KW steam dynamo, piping, condensing plant, and switchboard extensions. See "Official Notices" January 4th.

Eccles.—January 28th. The Corporation wants tenders for a 40-KW steam alternator. See "Official Notices" January 18th

Edinburgh.—February 6th. The Council wants tenders for the electric lighting installation at the Public Baths, Portobello. See "Official Notices" to-day.

Edinburgh.—February 9th. The Corporation invites tenders for an engine and dynamo for the McDonald Road electricity works. See "Official Notices" January 11th.

Holland.—March 25th. Tenders are being invited until March 25th next by the municipal authorities of Amsterdam, for the equipment of a central electric lighting station in the city.

Hull.—February 8th. The Works Committee wants tenders for a multipolar generator, to be coupled direct to a Belliss high speed engine, for the tramways undertaking. See "Official Notices" January 18th.

Launceston (Tasmania).—April 22nd. The Corporation wants tenders for the supply of 500 electric meters. See "Official Notices" January 11th.

L.C.C.—February 19th. The L.C.C. wants tender for the supply of two blocks of water-tube boilers for the tramways generating station at Camberwell. See "Official Notices" to-day.

Long Eaton.—The U.D.C. wants tenders for producers, gas engines, dynamos, and switchboard, feeder and distribution cables, and conversion of street lamps. See "Official Notices" to-day.

Luton.—March 4th. The T.C. wants tenders for electrically lighting the Council Chamber, Town Hall, Free Library, Corn Exchange, and Baths. See "Official Notices" January 18th.

New South Wales.—February 22nd. The *New South Wales Government Gazette* announces that tenders will be received at the offices of the Department of the Public Service Tender Board, 42, Young Street, Sydney, for the supply of (1) Telegraph material; (2) Telephone material; (3) Electric light material, all for the years 1901-2. Tender forms may be obtained and samples seen at the office of the Chief Electrican, General Post Office, George Street, Sydney. Samples may also be seen at the Postal and Electric Telegraph Stores, George Street, Sydney. The conditions as published in the *Gazette* may be examined on application at the Commercial Intelligence Branch, Board of Trade, 50, Parliament Street, London, S.W., any day between the hours of 10 a.m. and 5 p.m.

New South Wales.—March 4th. The *New South Wales Government Gazette* states that tenders will be received at the Railway Commissioners' Office, Bridge Street, Sydney, until Monday, March 4th, 1901, from persons willing to contract for the supply, delivery, and laying of about 29 miles of 6,600-volt three-core lead-sheated cable, and of about two miles of other cables, together with the necessary troughing, filling-in compound, armouring, &c.

Oldham.—January 29th. The Electricity Committee wants tenders for two 600-I.H.P and four 1,200-I.H.P. engines, each direct-coupled to a continuous current dynamo. See "Official Notices" January 4th.

Pietermaritzburg.—The *British and S.A. Export Gazette* says that the London agents for the Pietermaritzburg Town Council will shortly place a large order for electric light meters.

Poplar.—February 6th. The Guardians want tenders for brickwork, two Lancashire boilers, and economiser. See "Official Notices" January 18th.

Poplar and Stepney.—The managers of the Poplar and Stepney Sick Asylum wants tenders from firms willing to perform certain work in connection with the asylum installation. See "Official Notices" to-day.

Southampton.—February 11th. The Corporation wants tenders for car bodies and trucks, motors and equipments. See "Official Notices" to-day.

Southwark.—February 13th. The Electric Light Committee wants tenders for a 400-KW. high speed engine and dynamo, two water-tube boilers, mechanical stokers, steam mains, &c. See "Official Notices" to-day.

Spain.—The municipal authorities of Balazote (province of Albacete) have just invited tenders for the concession for the electric lighting of the town during a period of 40 years.

Spain.—February 21st. The Secretary for Foreign Affairs has received a dispatch from H.M. Ambassador at Madrid, stating that tenders are invited by the Spanish Government, not later than February 21st next, for the establishment of a telephone system in the City of Huelva; particulars at the Commercial Department, Foreign Office.

Sunderland.—February 1st. The Corporation wants tenders for condensing plant and cooling tower, secondary battery, mains switchboard, and travelling crane for the electric light station. See "Official Notices" December 28th.

The Hague (Holland).—March 25th. The Communal Council administration wants tenders for the supply and erection of engines and electric plant for the electric lighting of the town.

Tynemouth.—January 31st. The Corporation wants tenders for a 450-KW. steam dynamo. See "Official Notices" January 11th.

Victoria.—January 29th. Tenders will be received until Tuesday, January, 29th, for the supply and delivery of 20 miles of underground telephone cable. Specifications may be seen at the telegraph engineer's room, General Post Office, Melbourne. Tenders to be endorsed "Tender for 20 miles underground cable," and addressed to the Honourable the Postmaster-General, Melbourne. The *Victorian Government Gazette* containing the above notice may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament Street, any day between 10 and 5.

Wallasey.—February 21st. The U.D.C. wants tenders for the erection of car sheds, workshops, &c., also for extension of the electricity works (buildings and plant, including boiler, condensing plant, cooling tower, crane, engines and dynamos, cables, economisers and transformers). See two "Official Notices" to-day.

Wigan.—February 2nd. The E.L. and Tramways Committee wants tenders for two 210-KW. steam dynamos, two Korting condensers; certain piping; switchboards; feeder boosters and battery milker. See "Official Notices" January 18th.

Wimbledon.—February 18th. The U.D.C. wants tenders for the supply of steam and other piping; moving boilers, pumps, &c.; also supply of surface condensing plant and two water-tube boilers for electricity works extensions. See "Official Notices" January 18th.

CLOSED.

Brighton.—The T.C. has given a contract to the Union Cable Company of London and Berlin, for the supply of cable during the year ending December 31st next, at £11,986. Tenders are to be invited for the necessary machinery required in connection with the supply of electricity for tramway purposes.

Fulham.—Messrs. C. Cooper & Co. have secured the contract for electric wiring (Simplex tubing) at the Parish Receiving Room for the Guardians, at £185. The *Contract Journal* gives the following list of accepted tenders for the supply of stores and materials to the electric light station up to March 25th, for the Borough Council:—(Section 1) C. C. Wakefield & Co., oils; (1) Middleton Bros., sundries; (2) United Asbestos Company; (3) and (4) J. Knox & Co.; (5) and (6) General Electric Company; (7) Electric and General Contracting Company; (8) General Electric Company; (9) Electric and General Contracting Company; (10) General Electric Company; (11) and (12) Electric and General Contracting Company; (13) S. Z. de Ferranti, Limited; (14) General Electric Company.

Glasgow.—The Gas Committee has accepted the offer of the St. Helens Cable Company, Limited, for five miles of various sized steel tape armoured cable, at £1,147 6s.; also half a mile of triple-concentric cable for house services, at £259.

Greenwich.—Messrs. Lee & Warren have asked to be allowed to withdraw their tender for the electric lighting of Grove Park workhouse for the Board of Guardians, on account of an error of £250. This would have made their tender £5,160, £146 above Messrs. R. Dawson & Co.'s quotation. Messrs. Dawson's tender was accepted by the Board.

Glossop.—Messrs. Drake & Gorham are to carry out the electric lighting and motor installation at the Glossop new Technical School for the T.C. at £654.

Halifax.—The T.C. has accepted the tender of Messrs. Witting Bros., for the supply of 14 miles of electric underground cable. The amount is about £7,000.

FORTHCOMING EVENTS.

Friday, January 25th.—At 8 p.m. Institution of Junior Engineers. Meeting at Westminster Palace Hotel. Paper on "Railway Construction," by Mr. Alexander Ross, M.Inst.C.E., Engineer to the Great Northern Railway.

At 8 p.m.—Electro-Harmonic Society at St. James's Hall Restaurant. (*Abandoned.*)

At 5 p.m. Physical Society (at the rooms of the Chemical Society, Burlington House). Agenda: (1) "How Air made active by X Rays loses its discharging property and how it disperses Electricity," by Prof. E. Villari (Hon. Fellow); to be read by Prof. S. P. Thompson, F.R.S. (2) "Note on an Absolute Method for determining the Hygrometric State of the Atmosphere," by Mr. E. B. H. Wade, M.A. (3) "Exhibition of an Experiment on the Migration of the Ions," by Mr. S. W. J. Smith. Paper on "The New Physical Laboratories of the Royal College of Science," by Prof. A. W. Rücker.

At 4.30 p.m.—Norfolk House, Norfolk Street, W.C. Tramways and Light Railways Association. General meeting of members.

Saturday, January 26th.—The Institution of Electrical Engineers (Students' Section). Visit to the works of the India-rubber, Gutta-percha, and Telegraph Works, Company, Limited, Silvertown.

At 7 p.m.—Institution of Junior Engineers. Anniversary dinner at the Westminster Palace Hotel. (*Postponed.*)

Saturday, February 2nd. — Institution of Electrical Engineers. Students' visit to the Willesden Works of the Metropolitan Electric Supply Company.

Friday, February 8th.—At 8 p.m. Institution of Junior Engineers. Westminster Palace Hotel. Paper on "Electric Power Supply in the Metropolis," by L. F. Awde, member of Council.

Synopsis:—Extent of electric power at present supplied by Metropolitan companies—Provision for encouraging the adoption of electric power—Difficulties—Cost—Municipal influence—Situation of manufacturing districts—The coal question—Proposal to establish two large central stations for power supply, with generators on the three-phase system, at extra high voltage, the current transmitted to distributing centres and there transformed as required—Description of the stations—Mains, &c.—Capital cost and working charges—Losses in Distribution—Economy obtained—Conclusions.

NOTES.

The Queensland Post and Telegraph Department.—The report of this Department for 1899 states that the telegraph and telephone revenue amounted to £98,074 9s. 10d., an increase over that of the preceding year of £9,347 6s. Of this sum £12,574 8s. 11d. was contributed by the telephone service, which is rapidly becoming an important factor in connection with the revenue, as well as a great public convenience. The condition of many of the older telegraph lines is such that a very large expenditure for repairs, amounting in many instances to reconstruction, will have to be provided for at an early date. There has been an increase of over 30 per cent. in the number of telephone subscribers throughout the Colony during the year, and new exchanges have been opened at Cairns, Ipswich, and Mount Morgan. In Brisbane the underground system has been extended, and amounts to 25 miles of pipes, with 654 miles of pairs of conductors. The multiple switchboard has been extended to provide for 600 additional subscribers; even this capacity will shortly be exhausted. At the other exchanges, notably at Toowoomba, Rockhampton, Townsville, and Charters Towers, extensions continue to be necessary. The total calls throughout the Colony for the year are estimated (from periodical "counts") to equal over 3,500,000, of which over 2,250,000 were recorded in Brisbane; over 3,000 miles of wire are used in the 11 exchanges, of which 654 miles are underground. The trunk line from Brisbane to Ipswich has been extended to Toowoomba, and the business done on it is very satisfactory. At the present time the revenue from the use of the line, Brisbane to Ipswich and Toowoomba, is at the rate of over £1,000 per annum. Rockhampton has been connected with Mount Morgan by telephone trunk line, and the revenue from the use of this for the past year has been over £200. The capital expenditure on account of the telephone exchange system throughout the Colony now stands at £60,000. The revenue for the past year was £12,574, or an increase of over 40 per cent. on that of the previous year. The use of the telephone as a substitute for the telegraph in country districts is being steadily advanced. There are now 75 such offices open, as against 45 at the same date last year. The mileage of telegraph wire amounted to 18,969, the number of telegraph and telephone stations, 468. The total number of messages transmitted and received, 1,541,096.

Track Joints.—The *Street Railway Journal*, of Chicago, says that an inspection of the track laid a few years ago in a number of Western American cities where T-rail is the rule, and a careful observation of its condition, seem to point to the conclusion that no small part of the depreciation of track joints in places where girder rail is used is due to wagons which are driven on the track. At least it is hard otherwise to account for the way some of this T-rail is standing up under heavy service unless this is the case. Girder rails of corresponding strength, unless cast-welded, would not stand up the number of years some of this fish-plate joint T-rail construction has, without showing the joints very perceptibly. The tram of a girder rail is such a favourite driving place for all classes of vehicles that team traffic must surely have its effect on the wear at joints. Perhaps it will appear presently that the wide-groove rail is less of a thing to be avoided than has been formerly thought in cities were permission to lay T-rail cannot be obtained, as it will tend to keep teams off the track, and so not only help the schedule, but prolong the life of the joints, if for any reason it is not thought desirable to cast-weld them.

Wireless Telegraphy in Greece.—Port Plateali, where H.M.S. *Vulcan* was recently carrying out experiments with wireless telegraphy, is the scene of very frequent and severe thunderstorms, consequently there is ample opportunity to observe the effects of lightning upon the receiver. During a thunderstorm each lightning flash is recorded by a sharp click of the armature, and if the bell is left to "on" the flashes cause it to ring in response. Sometimes the flash is single and at other times a succession of rings show that the discharge is prolonged. The most usual sound produced by a flash of lightning, however, is what in the Morse code would be represented by "I E," that is to say, two shorts and one short. By the system of tuning, which may be done either with condensers as in Marconi's method, or by altering the length of the aerial wire as in Captain Jackson's method, a good deal of the effects of local disturbances can be reduced, but up to the present it has not been altogether got rid of. Marconi's latest pattern instrument, designed for use in the Navy, has been sent out to the *Vulcan* in order that it may be experimented with. Up to the present, however, the results of a few trials have not been nearly as satisfactory as was anticipated, This may very probably be due to the novelty of design, for Marconi's instrument differs in several minor details from the Admiralty pattern which has been in use hitherto. Signals were exchanged between H.M.S. *Tyne* and *Vulcan*, while the former was running mails between Platea and Patras. The distance between these two ports is, roughly, 50 miles, as the crow flies, and in a recent trial communication was lost about an hour and a half after the *Tyne* had started, which would represent a distance of about 10 or 12 miles. Later on, however, a few alterations having been made in the size of the jiggers used, without any very definite result, the idea was conceived of trying the effect of placing a condenser in the aerial wire instead of bringing it direct to earth. By this time the *Tyne* was at anchor in Patras, and on being called up by the *Vulcan*, she responded quite distinctly to the call, though no messages were exchanged. This experiment seems to give support to some ideas published by M. Guarini since June, 1899, in which he states that the interposition of condensers should greatly improve the transmission of signals in wireless telegraphy. M. Guarini has lately conducted some very interesting experiments (Electrical Review, January 11th and 18th, 1901) with condensers, using a telephone as a receiver, in which he demonstrates their utility, and is led to conclude by analogy that the same effects would be produced in the ordinary receiver of wireless telegraphy, a conclusion which the *Vulcan's* experience would seem in a measure to verify. We await with interest any further investigations that the *Vulcan* may make in this line. It is interesting to note that high land intervenes between Platea and Patras, and that, therefore, these signals are transmitted through large masses of rock and earth in which it is reasonable to suppose there is a certain quantity of mineral, and possibly metallic, substance.

Obituary.—We learn with great regret of the death of one whose name is a household word among all electricians everywhere—we refer to M. Z. T. Gramme, of Paris, who has just passed away at the age of 74 years. His inventive genius was centred upon the dynamo machine over 30 years ago, and it was in 1870 that his first patent was taken out. The Academy of Sciences had his first machine submitted to it in the following year, and it was so highly thought of, that the Volta prize of 20,000 francs was awarded to M. Gramme, the French Government also making a grant of a like amount. Dredge's "Electrical Illumination" accords him "the honour of devising a practical generator yielding absolutely continuous currents." One of his 1872 machines in which the permanent magnets were superseded by electro-magnets was brought to London in 1873 and for a time lighted the Clock Tower in the Houses of Parliament. In 1878 one of his machines was utilised for working the Jablochkoff light in the Avenue de l'Opera. The *Times* Paris correspondent says that Gramme had risen from very small beginnings. Brought up as a carpenter, he attended scientific lectures at Liége, when he showed a talent for machinery, and then went to Paris to a manufactory of lighthouse electric lamps. He next worked under Ruhmkorff and Disderi.

Glasgow Exhibition.—For lighting and power purposes a supply station is now being completed inside the Exhibition grounds. The boilers consist of Babcock and Wilcox and Stirling's types of water-tube, also several of the Lancashire type. Smoke stacks over 80 feet, and six in number, of welded steel, are now in position. Combined steam dynamo sets are being placed in position, and will amount in the aggregate to some 6,000 I.H.P. Among the makers are the following, for engines:—Willans & Robinson, Robey & Co., Davey, Paxman & Co., Ruston, Proctor & Co., Scott & Mountain, Alley & McLellan, Browett, Lindley and Co., Belliss & Morcom, and W. Sissons & Co.; for dynamos: Crompton, Schuckert, Mavor & Coulson, Scott & Mountain, Edison & Swan, Bruce Peebles, and Chapman. The main switchboard is being supplied by Kelvin and Jas. White, Limited, Glasgow. Main cables by the British Insulated Wire Company; the smaller cables by Frankenberg and the British Aluminium Company. The arc lamps by the Brockie-Pell Arc Lamp Company. Nearly 1,000 arc lamps will be in use throughout the Exhibition, besides some 500—mostly 16-C.P.—incandescent lamps. In this connection the Welsbach Company have undertaken to light and maintain during the run of the Exhibition the lighting of part of the grounds. The shafting in the Machinery Hall, as well as several working exhibits, to be driven by motors. The Schuckert Company, besides exhibiting in operation the searchlight used at Chicago and Paris Exhibitions, also intend exhibiting other machinery of their manufacture. The electric lighting arrangements are such that current can be obtained from the Glasgow Corporation mains by means of throw-over switches. The Corporation are helping forward the Exhibition very materially, and have now completed the lighting of the New Art Galleries, which form part of the show, and which also remain after the close of the Exhibition as a Museum and Art Gallery. The new electric tram system is now nearing completion, and there is every hope of having it fairly started before the opening by Royalty on May 7th, 1901. In this connection the Trams Department are arranging a circular route for visitors to the city, by which means tourists can take a run round the main sights of importance in the city and suburbs, starting from a central point, but they will not be allowed to alight, as the idea is merely to give an idea of the city's proportions—more lengthened visits being paid to sights at leisure. Many electrical accessories manufacturers are exhibiting, and nearly every country in the world has an exhibit of some kind.

Personal. — Mr. F. Vincent Mathias, formerly of Mount Pleasant, Windsor, and Bexhill, has been appointed chief assistant to the borough of Warrington electric light and tramway department.

We understand that at a meeting of the Electrical Works Committee of the Lincoln Corporation, Mr. C. S. Vesey Brown, the electrical engineer for the city, resigned his appointment. Mr. Brown has secured the appointment of general manager to the Northern Counties Electricity Supply Company, Limited, Newcastle-on-Tyne.

Mr. A. Tester, of Plymouth, has been appointed electrical engineer to the Lancaster Council. Mr. Tester is not to be governed by the borough engineer. It will be remembered that all the applicants for the post practically declined to be responsible to anybody but the Electrical Department Committee. Mr. Fraser, the Lancaster lighting station engineer, was due at Southampton on Saturday last, on his return from the war, where he has been serving as a sergeant in the Middlesex Yeomanry in South Africa. He resumes charge of the electric light works.

The Wimbledon U.D.C. has decided to appoint Mr. R. Torpy, of Bolton, as the new assistant electrical engineer. There were 48 applicants.

Appointments Vacant.—An assistant mains engineer is wanted for the Manchester electricity undertaking, at £200 per annum. The East Ham D.C. wants an outdoor assistant for the electric lighting and tramways department at £130 per annum. See "Official Notices."

The Nernst Imbroglio.—We deal in our City pages in the briefest possible way with the adjourned ordinary general meeting of the Nernst Electric Light Company, Limited. We understood from lengthy reports in the financial press that Mr. Zusman had given his word of honour as a gentleman on several occasions at the board meetings that if he were beaten he would immediately retire; this he has done, and the shareholders have been notified by circular to that effect, therefore, this unpleasant incident may presumably be taken as closed so far as the company is concerned. In a circular addressed to the shareholders, the other directors, Sir Henry Mance, Mr. J. G. Fort, and Mr. J. G. Dalzell, warmly supported Mr. Drake, whose services they considered had been invaluable to the company, and they, with the managing director, are to be congratulated on the result of the poll. We do not think any useful purpose would be served by going at greater length into the apparently loose and ill-founded charges made against Mr. Drake by his co-director, especially as our article of last week dealt with the subject in a sufficiently complete manner; the former gentleman has, by an overwhelming number of votes, completely vindicated his position, and we hope that the work of the company may now progress smoothly and uninterruptedly until the Nernst lamp becomes what its advocates trust and believe will eventually be the case, a commercially successful article.

Municipal Mismanagement.—The Cardiff Electric Lighting Committee is never happy except when it is muddling the affairs of the electricity department. Last week it spent some time squabbling over the title to be given to Mr. Ellis, who is the electrical engineer to both the lighting and tramways. The Council had previously decided that Mr. Ellis should not be styled "general manager" of the two departments, as this would make Mr. Harpur, the borough engineer, subordinate to him. Eventually it was decided that Mr. Ellis's title should be "borough electrical engineer and manager," a sufficiently indefinite conclusion. Mr. Ellis reported that whilst dealing with several breakdowns he had found many of the sub-stations in such a condition as to be "veritable death traps," and substantiated the statement with details of such gross negligence as amply justified his remark that there had been "absolute carelessness on the part of the outdoor department in the past." For this the Committee is, in our opinion, directly responsible, seeing that it repeatedly refused to furnish its electrical engineer with a full measure of authority.

Meetings Postponed.—Institution of Electrical Engineers.—We are informed that the adjourned discussion on Mr. Mordey's paper will take place on Thursday, February 14th, instead of on January 24th, and that no meeting of the Students' Section of the Institution will be held on Wednesday, January 30th. The meeting of the Manchester section will not be held next Tuesday.

The anniversary dinner of the Institution of Junior Engineers, which was to have taken place on Saturday, 26th inst., has been postponed.

The Dublin Section of the Institution of Electrical Engineers will not meet on 24th inst. The meetings of the Royal Society are suspended until further notice. The Institution of Civil Engineers' meeting on Tuesday, was adjourned without the transaction of business to Tuesday next, January 29th. The students' meeting announced for to-day is adjourned to February 1st.

The inaugural meeting of the Birmingham local section of the Institution of Electrical Engineers which was to have been held on Wednesday, 23rd inst., has been postponed.

The smoking concert of the Electro-Harmonic Society which was announced for this evening has been abandoned.

Lecture.—At the meeting of the Dundee Institute of Engineers on 17th inst. a lecture was delivered by Mr. David Scott on "Electric Motors of the Three-Phase Type without Commutators."

American Cars for British Tramways.—The *Tramway and Railway World* says that during the past year over 6,000 electric tramway cars were manufactured in America. The magnitude of the business will be better understood by recalling the fact that there are probably not more than 6,000 tramway cars of all kinds in use in the United Kingdom to-day. Unfortunately, from the standpoint of British workmen, our manufacturers are not yet able to supply the increasing demand for cars, and from all parts of the country complaints come of great delay in filling orders. One large Corporation was recently obliged to delay the opening of its electric tramways several months because cars could not be got. In the circumstances, it is not strange that private companies go to America to supply their needs.

Boers on the Rand.—A Central News telegram says that the Boers raided the works of the Rand Electric Supply Company at Brakpan on Sunday morning last and damaged the station plant. The works were expected to resume operations on Tuesday.

Gases.—On Friday last at the Royal Institution, Prof. Dewar lectured on "Gases at the Beginning and End of the Nineteenth Century."

NEW COMPANIES REGISTERED.

Hebburn Rope and Sail Works, Limited (68,969). This company was registered on December 29th, with a capital of £20,000 in £1 shares to acquire the whole or part of the Hebburn Rope and Sail Works, Hebburn-on-Tyne, and to carry on the business of hemp and wire rope, sail, cloth and sail makers, rope, cord and twine manufacturers, manufacturers of and dealers in all materials and things used in ships, collieries, and mines, wire workers and drawers, telegraph, telephone and electric light cable manufacturers, lightning conductor and electrical appliance makers, steam and hydraulic packing manufacturers, ship store dealers, &c. The first subscribers (each with one share) are:—J. E. Guthie, West Hartlepool, shipowner; D. T. Sharper, West Hartlepool, ship chandler; W. S. Merryweather, West Hartlepool, shipowner; W. B. Foxton, Hartlepool, biscuit manufacturer; J. F. Wilson, West Hartlepool, shipowner; J. H. Coverdale, West Hartlepool, shipowner; and J. R. Butterwick, Hartlepool, ship chandler. The number of directors is not to be less than three nor more than seven; the first are not named; qualification, £1,000; remuneration as fixed by the company. Registered office, the Rope Works, Hebburn-on-Tyne, Durham.

Barnsley Boiler and Engineering Company, Limited (68,967).—This company was registered on December 29th, with a capital of £5,000 in £1 shares, to acquire the business carried on by G. Denton, at Barnsley, Yorks., to adopt an agreement with W. Carr, and to carry on the business of manufacturers and vendors of boilers, machines, engines, colliery corves and appliances, electrical, mechanical and general engineers, founders, smiths, tool makers, tube manufacturers, &c. The first subscribers (each with one share) are:—T. Marsland, Silkstone Common, near Barnsley, colliery agent; J. Nall, Barnsley, box manufacturer; H. H. Woodruff, Barnsley, timber and coal merchant; H. W. Rymer, Hall Bank, Barnsley, clerk; A. P. Woodruff, Barnsley, coal and timber merchant; Mrs. K. E. Woodruff, Barnsley; and W. E. Raley, Barnsley, solicitor. The number of directors is not to be less than three nor more than six. The first are T. Marsland, J. Nall and A. P. Woodruff; qualification, £100. Registered office, Summer Lane Works, Barnsley.

Herne Bay and Canterbury Light Railway Syndicate, Limited (68,891).—This company was registered on December 28th, with a capital of £2,000 in £1 shares, to adopt an agreement with R. Warner, to acquire or enter into and carry out contracts for making, purchasing, or working railways, tramways, telegraph, and telegraph lines, electric and other lighting, hydraulic and other works, and for the equipment thereof with electric plant or otherwise, and to carry on the business of contractors generally. The first subscribers (each with one share) are:—C. H. Wood, Kirkdale Road, Leytonstone, E., director; R. M. Clarke, 5, Garfield, Woronzow Road, Regent's Park, N.W., clerk; F. C. Rhys, 74, Coleman Street, E.C., accountant; J. T. Shields, 9, Coleman Street, E.C., agent; W. F. Shields, 9, Coleman Street, E.C., merchant; W. H. Knight, 50, Amott Road, S.E., accountant; and A. L. George, 159, Cannon Street, E.C., clerk. Table "A" mainly applies.

Moon, Loughlin & Co., Limited (68,929).—This company was registered on December 29th, with a capital of £20,000 in £1 shares, to acquire the business carried on by O. Moon and J. A. Loughlin at the Luna Works, Factory Lane, Harpurhey, Manchester, as Moon, Loughlin & Co., and to carry on the business of electrical and general engineers, electricians, manufacturers of electrical appliances, brass and ironfounders, machine and tool makers, &c. The first subscribers (each with one share) are:—O. Moon, Luna Works, Factory Lane, Harpurhey, Manchester, electrical engineer; J. A. Loughlin, of the same address and occupation; F. J. Moon, 83, Corporation Street, Manchester, hotel keeper; W. McGuffin Greaves, Market Street, Manchester, engineer; Mrs. G. M. Zapata, Mount Broughton, Higher Broughton, Manchester; J. Welsh, Sefton Villa, Cheetham, Manchester, calico printer; and H. J. L. Bull, Oak Avenue, Chorlton-cum-Hardy, electrical engineer. The number of directors is not to be less than two nor more than five; the first are O. Moon and J. A. Loughlin, each of whom may retain office so long as he holds 250 shares; remuneration as fixed by the company. Registered office, Luna Works, Factory Lane, Harpurhey.

Lawson's Non-Conducting Composition, Limited (69,203).—This company was registered on January 15th, with a capital of £2,000 in £5 shares, to acquire so much of the business of George Angus & Co., Limited, as consists of manufacturing and dealing in improved asbestos compound non-conducting composition for covering steam pipes, tanks, refrigerators, trade utensils, and other vessels now carried on by them at Narrow Street, Limehouse, E. (except the export department of the same), to carry on the said business, and to manufacture and deal in fireproof materials, insulating materials and appliances for electric cables, wires, and electrical insulation generally, engineers' requisites, &c. The first subscribers (each with one share) are:—A. J. Lawson, Hatfield, Weston-super-Mare, soap manufacturer; Mrs. J. D. Lawson, Hatfield, Weston-super-Mare; Miss E. J. Lawson, Hatfield, Weston-super-Mare; G. Hutchinson, Elswick House, Knowle, Bristol, chemist; Mrs. M. J. Hutchinson, Elswick House, Knowle, Bristol; T. R. Hutchinson, Elswick House, Knowle, Bristol, engineer; and H. E. F. Toope, 58, Wells Road, Bristol, accountant. Minimum subscription, £600. The number of directors is not to be less than three nor more than five; the first are A. J. Lawson, T. R. Hutchinson, and A. Cocks; qualification, £50. Registered office, 140, Minories, E.

Electric Traction Construction and Equipment Company, Limited (68,948).—This company was registered on December 29th, with a capital of £20,000 in £100 shares to construct or acquire railways, tramways, vehicles, launches, steamboats and other means of conveyance, and to carry on the business of railway, tramway, boat and vehicle proprietors, electrical, marine, mechanical and general engineers, contractors, suppliers of electricity, electrical and other motor manufacturers, cycle makers, &c. The first subscribers (each with one share) are:—W. D. Wicks, 3, Cumberland Road, Acton, W., accountant; J. Douglas, 58, St. Kildas Road, Stoke Newington, N., accountant; H. Lafone, 11, King Street, St. James's, S.W., gentleman; H. P. Hussey, 10, Evelyn Mansions, Carlisle Place, S.W., secretary; G. Cox, 17, Tower Royal, E.C., solicitor; W. Wheeler, 6, Essendine Road, Maida Vale, W., accountant; and R. H. Peet, 42, Elmfield Road, Upper Tooting, S.W., engineer. The number of directors is not to be less than three nor more than five; the first three are to be appointed by the intending subscribers for shares Nos. 1 to 50, 51 to 100 and 101 to 150, respectively. Remuneration as fixed by the company. Registered office, 17, Tower Royal, E.C.

Middleton Electric Traction Company, Limited (68,935).—This company was registered on December 29th, with a capital of £100,000 in £5 shares, to carry on the business of carriers of passengers and goods, electrical engineers, electricians, manufacturers and dealers in rail, tram, electrical, and other apparatus, mechanical and chemical engineers, &c., and to acquire any patents relating to the propulsion of rail and tram cars, carriages, trucks and craft. The first subscribers (each with one share) are:—E. Garcke, Donington House, Norfolk Street, W.C., managing director; C. S. Hilton, Donington House, Norfolk Street, W.C., director; J. Devonshire, 2, Stafford Terrace, Shellimore Gardens, W., electrical engineer; E. Hopwood, 35A, Hertford Street, Mayfair, W., secretary; H. M. Sayers, Donington House, Norfolk Street, W.C., electrical engineer; G. J. Somerville, Surrey House, Victoria Embankment, electrical engineer; A. L. Barber, Donington House, Norfolk Street, W.C., clerk. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers; qualification, £250; remuneration, £50 per annum each, together with a percentage of the profits, divisible.

Badger, Sons & Co., Limited (68,995).—This company was registered on December 29th, with a capital of £3,000 in £1 shares, to acquire the business carried on at Cupola Works, Masbrough Street, Rotherham, as "William Badger, Sons & Co.," and to carry on the business of mechanical and electrical engineers, steel, iron, brass, and metal founders, boiler makers, iron and steel converters, &c. The first subscribers (each with one share) are:—W. Badger, sen., Victoria Villa, Masbrough, Rotherham, engineer and electrician; J. Badger, Victoria Villa, Masbrough, Rotherham, engineer and electrician; W. Badger, jun., Victoria Villa, Masbrough, Rotherham, engineer; H. Badger, Victoria Villa, Masbrough, Rotherham, mechanical and electrical engineer; A. Badger, Victoria Villa, Masbrough, Rotherham, mechanical and electrical engineer; Mrs. A. Badger, Victoria Villa, Masbrough; and V. Lof, 50, Clough Road, Masbrough, Rotherham, steel foundry manager. Registered without articles of association. Registered office, Cupola Works, Masbrough Street, Rotherham.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Westinghouse Electric and Manufacturing Company, Limited (62,919).—This company's annual return was filed on December 12th, when 100,000 preference and 45,000 ordinary shares were taken up out of a nominal capital of £1,750,000 in 20,000 preference shares of £5 each, and 75,000 ordinary shares of £10 each. £5 has been called up on each preference share, resulting in the receipt of £500,000. £450,000 is considered as paid on the ordinary shares.

SUPPLY STATION ACCOUNTS.

Bedford Corporation Electricity Accounts.

ALTHOUGH the last published accounts of the electricity supply undertaking of the Bedford Corporation show a loss in the net revenue statement, it is a hopeful sign to note that the amount by which the financial charges are in excess of the gross profit is rapidly diminishing, and we look forward to the 1900 accounts to prove that all charges have been met. Thus the net losses have been as follows:—

Year.	1897.	1898.	1899.
Net loss	£1,200	£981	£288

An improvement of nearly £1,000 in three years is by no means a bad result. As the capital invested is still very reasonable, and the output has now reached a figure exceeding half a million units, with a revenue of close upon £9,000, the outlook is favourable.

GENERAL STATEMENT.

	1898.	1899.	Increase.
Total capital expenditure ...	£58,300	**£67,621**	£9,321
Number of units sold	328,343	**540,146**	211,803
Number of lamps connected ...	17,411	**25,368**	7,957
Maximum load in KW.	340	**449**	109
Gross revenue	£5,874	**£8,798**	£2,924
Gross expenditure	£3,696	**£4,881**	£1,185
Gross profit	£2,178	**£3,917**	£1,739
Average price per unit sold ...	4·18d.	**3·82d.**	—·63d.

The increase in revenue of £2,924 is nearly 50 per cent. upon the total of 1898. Owing to much of the additional output being motor load, the average price received per unit has dropped ½d. from about 4½d. to 3¾d., bringing down the total average per unit below 4d. The output was distributed as follows:—

Year.	Units at 6d.	Units at 4½d.	By contract.	Public lighting.	Pumping sewage.
1898 ...	£1,641	£1,920	£25	£2,131	—
1899 ...	—	£4,898	£18	£2,524 (at 3d. per unit)	£1,111 (at 3d. per unit)

The public lamps at the beginning of 1899 numbered 508, varying from 16-C.P. to 200-C.P. incandescent. The capacity of plant installed was 670 KW., and the price charged for lighting was 5d. less 10 per cent. for cash in one month, while power and public lighting were charged 3d. per unit, this figure in the latter case including attendance and renewals.

REVENUE STATEMENT.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£5,718	4·18d.	**£8,591**	3·82d.	—·36d.
Meter rents	141	·10d.	**193**	·09d.	—·01d.
Sale of lamps, &c.	—	—	—	—	—
Sundry receipts	15	·01d.	**14**	·00d.	—·01d.
Gross revenue ...	£5,874	4·29d.	**£8,798**	3·91d.	—·38d.

Roughly the output increased by 66 per cent., while the costs have increased by only 33 per cent. in 1899. The items which show appreciable alteration in the cost sheet are coal, wages and other expenses. Coal has risen from just under to just over 1 1/10d. per unit, and represents more than half the total cost of production. Wages have been reduced from the gross sum of £901 to £825, and this has brought down the item per unit from ¾d. to under ⅔d., a fall of almost 3/10d. In 1898 there appears an item "lamps supplied to customers," £241; but this is absent in the following year's accounts. The economising of wages has enabled the works costs to be reduced below 2d., and the omission of other expenses has caused a total drop of over ½d. compared with 1898, so that the total cost now stands at under 2⅓d.

COST OF PRODUCTION.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal, and unloading same	£1,459	1·07d.	£2,535	**1·13d.**	+·06d.
Oil, waste, water and engine room stores	228	·16d.	372	**·16d.**	—·00d.
Salaries and wages incurred in generation and distribution and attendance on public lamps	901	·66d.	825	**·37d.**	—·29d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c., and street lamps	311	·23d.	419	**·19d.**	—·04d.
Works cost ...	£2,899	2·12d.	£4,151	**1·85d.**	—·27d.
Rent, rates and taxes ..	166	·12d.	183	**·08d.**	—·04d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	280	·20d.	360	**·16d.**	—·04d.
General establishment charges, stationery and printing, law charges and insurance	110	·08d.	187	**·08d.**	·00d.
Other expenses: Lamps bought for customers	241	·18d.	—	—	—·18d.
Total costs ...	£3,696	2·70d.	£4,881	**2·17d.**	—·53d.

The amount required for interest and sinking fund increased by £1,046, although, worked out at per unit, this was a fall of from 2·31d. to 1·87d. The gross profit, however, was augmented by £1,739; the difference between these two sums, or £693, enabled the net loss to be reduced from £981 to £288, *i.e.*, from ·72d. to ·13d. per unit. The gross profit was equal to 1·59d. in 1898 and 1·74d. in 1899.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans..	£1,399	£1,836
Sinking fund for repayments	1,760	2,369
Net profit carried forward	—981	—288
Gross profit	£2,178	£3,917

CITY NOTES.

The Renewable Electric Lamp Company, Limited.

REPORT of the directors, to be presented at the ordinary general meeting of the company. The annual meeting of this company was held on Tuesday, January 22nd, at Brunswick Works, City Road, N. The report submitted reads as follows:—

"The directors present the auditors' accounts of the company for the period ending September 30th, 1900. Having obtained premises for the works on advantageous conditions, as reported at the statutory meeting, the company secured a small supply of lamps from English and foreign manufacturers, with the intention of meeting orders with these pending the equipment of the works. This system, however, proved unsatisfactory, and it was deemed advisable

to restrict the number of lamps supplied, the board being of opinion that it was more in the interests of the proprietors that there should be some delay in commencing trading than that it should be prejudiced by the supply of lamps which the company was unable to guarantee, even though this course has necessitated a loss of £3,393 while the business was being established. The equipment of the factory was delayed by the difficulty of getting prompt delivery of electrical appliances at a time when manufacturers were extremely busy. In August last the works were sufficiently advanced to commence manufacturing on a moderate scale, and the output is now at the rate of 4,000 lamps per week, which find a ready market. The commercial value of the lamps being established, the output is being steadily increased as the necessary organisation and training of hands permit, and it is hoped that it will soon reach a figure commensurate with the size of the undertaking. The retiring director, Mr. J. E. Touch, is eligible, and offers himself for re-election. Messrs. G. A. Touch & Co. offer their services as auditors for the ensuing year."

In the absence of Mr. J. Atherton, Mr. H. E. Kershaw presided. In moving the adoption of the report, Mr. Kershaw read a statement which had been prepared by Mr. Atherton for the meeting. It was to the effect that the company had been progressing slowly. Since the statutory meeting they had found it a wise course to delay trading rather than prejudice the future of the company by placing lamps upon the market before the business was sufficiently organised to supply lamps of the various sizes. They were now able to supply lamps as good as, and in many respects superior to, any British-made lamp. They had to train the whole of the work-people step by step. They were now employing 50 work-people, but would be able to accommodate 300. Seeing the magnitude of the undertaking, the results were not surprising. They were now on a working basis, and the success of the company should commence from that time. They had dispensed with their former works manager and had appointed a new one who had had considerable experience in managing a similar lamp factory. Mr. Kershaw added on his own behalf that the progress of the works was going on quite satisfactorily. They had no difficulty in obtaining orders for the lamps; the only difficulties had been in their manufacture. The difficulties had now been practically overcome, and they would start increasing the output at the rate of 50 lamps per day from that time. As soon as they could turn out 6,000 lamps per week they would be on a profit-earning basis. The report said that 4,000 lamps per week were turning out, but 3,000 would have been more like the actual state of things. They had been waiting for a furnace from America, and this had now arrived.

A Shareholder remarked that the company had taken out a patent for the renewal of any kind of lamp. Could they renew any lamp?

The Chairman said that they would rather not discuss that matter; they were waiting until the end of the month, when they would be prepared to do so. The same shareholder asked why they had withdrawn their advertisement from the technical press, and in reply, Mr. Kershaw said that he desired to withdraw all advertisements and suspend many of the supplies, until they had a working stock. They required a very large stock to enable them to supply lamps of voltages varying from 5 to 50 c.p. to meet the demand. The travellers had also been suspended for three months with the same object in view. There was absolutely no anxiety as to the ultimate success of the undertaking. The delays had been caused by circumstances absolutely beyond their control.

The adoption of the report was seconded by Mr. Touch, and unanimously carried. The retiring director was re-elected, and Messrs. G. A. Touch & Co. were elected auditors. The usual vote of thanks closed the meeting.

Metropolitan Railway Company and Electric Traction.

The report of the directors, to be submitted at the half-yearly general meeting to be held in London on the 25th inst., states that the total receipts for the half-year ended December 31st (deducting this company's proportion of the revenue of the City lines and extensions) have been £422,459, and the expenses £212,462, leaving a profit of £209,997. The receipts show a decrease of £12,316 and the expenses an increase of £13,313, as compared with the corresponding half-year of 1899. In July last the Central London Railway commenced working, charging the low fare of 2d. between Shepherd's Bush and the City, a distance of 6½ miles, and this competition has very seriously affected the receipts on the Circle and Hammersmith and City lines. Certain changes in the working have been made, and others are under consideration, with a view to economies being effected, which, it is hoped, will mitigate the result of this competition without impairing the efficiency of the undertaking. The proprietors are aware that experiments have for some time been going on with the object of proving the adaptability of electrical traction to meet the requirements of the traffic of the railway, and in August last the Electrical Traction Joint Committee appointed by the Boards of the Metropolitan and District Railway Companies invited leading electrical traction firms to submit proposals for working the Inner Circle by electricity. Nine proposals or tenders have been received and reported upon. The committee, however, before coming to any definite decision, have requested the engineers, Sir William H. Preece, K.C.B., and Mr. Thomas Parker, to make a thorough examination of the system proposed by one of the firms, which appears to possess special advantages both as regards cost of construction and working. Should this examination prove satisfactory, and the report of the engineers be favourable, the directors believe the proprietors will have no cause to regret the delay that has taken place in the application of electricity to the working of their system. Resolutions will be submitted at the special meeting providing for the creation of the capital authorised by the Metropolitan Railway Acts, 1881 and 1882, and the exercise of the borrowing powers conferred by those Acts. The board anticipate that these powers—with those now available—will be sufficient to provide the necessary funds for liquidating the debit to the capital account, and for the installation of electrical traction on the railway.

Nernst Electric Light, Limited.

The adjourned general meeting of this company was held last Friday at Westminster Palace Hotel, Sir Henry Mance presiding.

The Chairman called upon Mr. Drake to resume the discussion. Mr. Drake in the course of his speech made a proposal to the effect that the issues being clearly defined in the charges of Mr. Zusman, and in his replies thereto, they should be submitted to the Rt. Hon. Mr. Asquith, Q.C., or Sir Robert Reid, Q.C., to give his findings upon them.

Mr. Zusman said that he refused the proposition.

Mr. J. G. Dalzell (a director) then moved as an amendment to the amendment moved at the last meeting, that the meeting intimate to Messrs. Drake and Zusman their desire that the course suggested be adopted.

There was now a prolonged and exceedingly heated discussion, the result of which was that 17 voted for the amendment and 20 against.

The Chairman then intimated that that effort to stop the discussion having failed, he would call on Mr. Drake to continue his reply.

Mr. Drake then read a lengthy reply to the rejoinders which had been circulated by Mr. Zusman. Mr. Zusman replied at considerable length, but the details of these speeches are of no particular interest, as the statements were to a great extent personal ones. The feeling of the meeting, however, was shown when the vote was taken on the original motion to adopt the report and accounts. There were 30 in favour and 12 against the motion. Mr. Zusman accordingly demanded a poll, and when this was taken at the close of the meeting it was found that there were 120,766 shares for the report and only 46,871 against, a majority in favour of the board and Mr. Drake of 73,895.

Sir Henry Mance was unanimously re-elected a director.

Mr. Hess, on behalf of German holders of 100,000 shares, said that they wanted to be represented on the board, and he brought forward the name of Mr. J. H. H. Duncan, an accountant, and the late chairman of the New Sunlight Incandescent Company. It was not, however, felt by the meeting that such a step was necessary or advisable at the moment, and Mr. Hess withdrew his representation.

An extraordinary meeting was subsequently held at which certain slight alterations in the articles required to comply with the Stock Exchange requirements were approved.

Eastern Telegraph Company.

The report of the directors for the half-year ended September 30th, states that the revenue amounted to £642,145, from which are deducted £131,862 for the ordinary expenses and £45,582 for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £6,572 for depreciation of spare cable and £10,526 for income-tax, there remains a balance of £447,602, to which is added the sum brought from the preceding half-year, making a total available balance of £449,527. From this balance there has been paid interest on mortgage debenture stock, dividends on preference stock, two interim dividends of 1½ per cent. each on the ordinary stock, and, after carrying £10,000 to the reserve fund for maintenance ships and £250,000 to the general reserve fund, there remains a balance of £30,932, which is carried forward to the next account. The revenue includes £23,225 dividends for the half-year upon the company's investments in other telegraph companies. The large sum placed to reserve is to provide for the payment of certain of the instalments, on account of cables now being laid by this company between Great Britain, the Cape, and Mauritius, which, in conjunction with the cables undertaken by the Eastern Extension, Australasia and China Telegraph Company, will form the new through route between Great Britain and Australasia.

Direct United States Cable Company.

The report for the half-year ended December 31st states that the revenue, after deducting out-payments, amounted to £50,533, as compared with £56,800 for the corresponding period of 1899. The working and other expenses for the same period, including income-tax, but exclusive of cost of cable repairs, amounted to £20,826, leaving a net balance, including £3,761 brought forward, of £33,468. For the corresponding period of 1899, the working expenses and other payments amounted to £20,416. Interim dividends amounting to £18,213 have been declared, and £10,000 is placed to reserve, the balance of £5,255 being carried forward. The reserve fund account has been debited with £2,500 for cost of cable repairs, and after being credited with interest on the investments and amount set aside from revenue, the balance of the reserve fund account, taking the investments at cost price, now amounts to £433,105.

Prospectus.—We have before us a prospectus of Crowther and Co.'s Electrical Industries, Limited, a Manchester and Liverpool company of electrical engineers and contractors for electric light and power plant. The capital is £10,000 in £1 shares, and preference is to be given to customers of the firm of Crowther and Co., whose business is to be taken over. The prospectus states that the firm has been established for some years, and has succeeded in forming a sound and profitable business. The company "is intended as the pioneer of a larger company," and the shares are proposed to be offered for "private subscription only." Increase of business has necessitated increase of capital and of the scope of the work to be carried out. It appears that no audit of the books has been made periodically, so that the profits are not stated, but it is said that the business in hand authorises an estimate sufficient to pay 10 per cent. on the capital proposed to be called up. For the stock, goodwill, &c., £2,500 is to be paid, £1,500 in shares and the balance in cash or shares.

Anglo-American Telegraph Company.—The board has resolved, after placing £12,000 to the credit of the renewal fund for the half-year, to recommend at the meeting to be held on February 1st the following dividends:—

1. A balance dividend of 17s. 6d. per cent. upon the ordinary consolidated stock for the year ending December 31st, 1900.
2. A balance dividend of £1 10s. per cent. upon the preferred stock for the year ending December 31st, 1900.
3. A first and final dividend of 5s. per cent. upon the deferred stock for the year ending December 31st, 1900, all payable on February 2nd next, less income-tax, to the stockholders registered on the books of the company on January 7th.

After paying the foregoing dividends there will be a balance of about £1,150 to be carried forward to the next account. The above dividends, together with those already paid, amount to £3 2s. 6d. per cent. on the ordinary consolidated stock, £6 per cent. on the preferred stock, and 5s. per cent. on the deferred stock for the year 1900. The register of transfers will be closed from January 19th to February 1st.

Stock Exchange Notices.—Application has been made to the Committee to appoint a special settling day in and to grant a quotation to—Brisbane Electric Tramways Investment Company, Limited—75,000 ordinary shares of £5 each; 75,000 5 per cent. cumulative preference shares of £5 each; and £400,000 4½ per cent. first debenture stock. The Committee has appointed special a settling day as under:—Wednesday, January 23rd. County of London and Brush Provincial Electric Lighting Company, Limited —Furthur issue of £100,000 4½ per cent. debenture stock, and has ordered same to be quoted in the Official List.

Liverpool Overhead Railway Company. — The accounts for the past half-year show an available balance of £15,829, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares, and 3½ per cent. per annum on the ordinary shares, against 5 per cent. per annum on the ordinary shares for the corresponding period last year. Balance carried forward £4,080, against £4,592.

St. James's and Pall Mall Electric Light Company. —The directors recommend a dividend for half-year ending December 31st of 7s. 6d., together with a bonus of 2s. per share on the ordinary shares, making, with the interim, a dividend of 12½ per cent. and a bonus of 2 per cent. for the year 1900.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending January 18th were £411 9s. 6d.; corresponding week last year, £366 2s. 5d.; this year's increase, £45 7s. 1d. Total to date, £1,060 19s. 1d.; corresponding period last year, £960 5s. 7d; increase, £100 13s. 6d. Miles open, 8½.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending January 19th were £127; corresponding week last year £140; decrease, £13. Total to date, £391; corresponding period last year, £423; decrease, £32.

Bristol Tramways and Carriage Company.—The receipts for the week ending January 18th were £3,747 12s. 0d.; corresponding period last year, £2,715 1s. 4d.; increase, £1,032 10s. 8d.

Central London Railway.—The receipts for the week ending January 19th were £5,982; previous week, £5,676; increase, £306. Total receipts to date (25 weeks), £138,985. Miles open, 6.

City and South London Railway.—The receipts for the week ending January 20th were £1,995; corresponding week last year, £1,111; increase, £884. Total to date, £6,054; corresponding period last year, £3,379; increase, £2,675. Miles open, 1901, 4½; 1900, 3½.

Dover Corporation Tramways.—The receipts for the week ending January 19th were £168 12s. 4½d.; corresponding week last year, £149 16s. 11½d.; increase, £18 5s. 5d. Total to date, £465 5s. 4d.; corresponding period last year, £454 13s. 11d.; increase, £10 11s. 5d. Miles of track open, 3. Car miles run, 1901, 4,969; 1900, 4,939. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending January 18th were as follows:—D. U. T. Co., electric cars, £3,254 15s. 8d.; ditto, horse cars, £6 0s. 4d.; D. S. D. Co., electric cars, £6-6 13s. 8d.; total, £3,947 9s. 8d.; corresponding week last year—D. U. T. Co., electric cars, £2,864 18s. 10d.; ditto, horse cars, £97 15s. 2d.; D. S. D. Co., electric cars, £608 10s. 6d.; total, £3,571 4s. 6d.; increase, £376 5s. 2d.; aggregate to date, £10,256 6s. 11d.; aggregate to date last year, £9,110 6s. 4d.; increase, £1,146 0s. 7d. The mileage worked is 44 miles electrically, 1 mile by horses, as against 37 miles electrically, 7 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending January 20th were £1,482; corresponding week last year, £1,471; increase, £11. Total to date, £4,537; corresponding period last year, £4,455; increase, £82. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

In deep and impressive silence the Stock Exchange received the announcement that the House would be closed soon after 11 o'clock this (Wednesday) morning. No business had been transacted up to that time, and quotations were unaltered from Tuesday night's closing prices. The brief period of suspense which prevailed before the national calamity befell us, had worked its effect amongst high-class investment securities, but now there is a consensus of opinion in the Stock Exchange that prices will give way to no further appreciable extent. Consols have led the weakness in gilt-edged investments, but for this flatness of the funds there is a special reason in the shape of anticipations of a fresh war loan. Gilt-edged electrical stocks, however, are holding their ground with quiet strength, and there is no decline observable in the price list of shares. Not that a slight relaxation of their positions would have been at all remarkable in the Debenture stocks, many of which have been creeping up of late. Yet the fact remains that there is no slackening, and there has even been some little demand for this class of investment. City of London Second Debenture has also come into request.

In the share list proper Westminsters exhibit a rising tendency, and are 10s. to the good, although the dividend is not expected for another few weeks. The St. James's and Pall Mall announcement may be expected at any moment, this company being very smart in making up its accounts. (See announcement in preceding column). New Kensingtons are 4⅞ premium, and cannot be called expensive at that; the old shares are now quoted *ex* the right of applying for the new issue. City of London shares fail to regain their last week's decline, and Smithfield Debenture stock is flat.

Improved prices characterised the Central London Railway market, principally on the idea, suggested last week, that the coming report will put a better face on matters than the pessimists had been doing. The Ordinary and the Preferred are both better, but the cheerier views have had no effect upon the Deferred halves. There is no change to report in City and South London stock, it being considered in the market that full discount had already been made in connection with that reduced dividend to which we referred last week. Waterloo and City stock, secure in its practically guaranteed 3 per cent. from the London and South-Western Railway, is unaltered at the near approach of the distribution time. The numerous feeders projected by the light railways—and particularly by the Central London—are regarded with favour in the market, which argues learnedly about the overcrowding in the metropolis, and hopes great things from the Islington to Euston, the Hammersmith Broadway, and other extensions of the "Twopenny Tube." And how great a power the Central London is becoming can be gauged by the report of the Metropolitan Railway. In that document the directors excuse the greatly diminished dividend by referring to the very severe loss occasioned to the Underground Railway by the coming of the Central London. The District report is not yet published, but a similar story may certainly be expected from it.

Discussing dividends leads to a notice of the sharp fall that has taken place in Anglo-American Telegraph Company's stocks on what is regarded as a very bad showing. The Deferred stock is to receive a dividend of a paltry 5s. for the whole year, which makes it abundantly clear that German competition and the non-chartering of the company's repair ship have far outweighed advantages accruing on account of the boom in American rails. In our last week's issue we suggested that too much heed was not to be taken of an obviously interested letter which had appeared advising a purchase of Anglo "A" stock. A fall of 1¼ this week is sufficient commentary on our previous remarks.

The Eastern Telegraph report is so good as to elicit surprise that no response should have been made to it in the price of the stock. The company has just made up its dividend to the usual 7 per cent. for the year, and carries to reserve a sum representing another 6 per cent. At its present quotation the stock pays exactly 5 per cent. on the money. Eastern Extension new shares are harder on the week, and Cuba Telegraph Preference are a point better. Telephone descriptions are featureless.

Papers are now being sent to Brush Electrical shareholders, inviting them to sell their shares to the British Electric Traction in the proportion of one traction for 7½ Brush, both fully paid. The sale is, of course, purely optional, and proprietors of Brush shares can apply the right either to a part of their holding or to the whole of it. There is so little advantage to be gained that we doubt whether Brush proprietors will put themselves to the trouble of making the exchange.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations Jan. 16th.	Closing Quotation Jan. 23rd.	Business done during week ended Jan. 26rd, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102 xd	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3⅛%	52 — 55	51 — 54	...	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	97 — 99	96 — 98	98⅞	96¾
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	10 — 10½	8¾— 9½	10⅜	8⅝
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3½	3 — 3½	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	170 —180	170 —180	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	103½	102
16,000	Cuba Telegraph	10	8 %	7 %	...	7 — 8	7 — 8	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	15½— 16½	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100-104%	100 —104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	...	10 — 10½	10 — 10½	10 5/16	...
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	136 —141 xd	137 —142	139¾	136
1,326,888	Do. 3½ % Pref. Stock	100	...	...	...	95 — 98 xd	95 — 98	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	109 —113	109 —113	111½	110
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	14 — 14½xd	14 — 14½	14⅛	14
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) £8 pd.	10	...	...	...	11½— 12	11¾— 12¼	11⅝	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	112 —117	112 —117	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	99 —102%	99 —102%	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	...	10½— 10¾	10½— 10¾	10¼	...
180,042	Do. do. 6 % Pref.	10	6 %	...	...	15 — 15½	15 — 15½	15½	..
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	31 — 35	32 — 34	...	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	47 — 51	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	104 —107	104 —107	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	⅜— 1	⅜— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	...	4⅛— 4⅜	4⅛— 4⅜	4 5/16	4⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	12 — 14	12 — 14	13¼	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	6 %	...	4⅞— 5⅛	4⅞— 5⅛	4 1/16	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	...	94 — 97	94 — 97	95¼	94½
500,000	Do. 4 % Deb. Stock Red.	100	...	...	...	97 —100	97 —100	99	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1⅛	⅞— 1⅛	⅞	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4¾— 5¼	4¾— 5¼	4⅞	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
23,361	Do. do. Nos. 16,640 to 40,000 £3½ pd.	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	...	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Brss. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13¾— 14¼	13¾— 14¼	14⅛	13⅞
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	5%	...	⅝— ⅞	⅝— ⅞	⅝	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	6 — 7	6 — 7	6 7/16	6½
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	...	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	...	9½— 10½	9½— 10½	...	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5¾	5½— 5¾	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	...	6½— 7	6½— 7	6⅝	6⅜
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	...	8½— 9⅛	8½— 9½	9 1/16	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	13 — 14	14	13⅞
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	...	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	12	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	106 —109	105 —109	106¾	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4½— 5 xd	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	101 —103 xd	101 —103	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	..	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	...	12 — 13	12 — 13	12⅜	12
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	98¼	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	...	14½— 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	...	15 — 16	15 — 16	...	..
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	...	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	..	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2⅛— 3⅛	2⅛— 3⅛	2 1/16	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	...	12 — 13	12½— 13½	...	...

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Jan. 16th.	Closing Quotation Jan. 23rd.	Business done week ended Jan. 23rd, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	8½ — 9½	8 — 9	8¼	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	12½ — 13½	12½ — 13½	...	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11½ — 12½	11½ — 12½	...	...
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	...	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	½ — ¾	½ — ¾	...	...
50,000	† Do do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	⅝ — ⅞	⅝ — ⅞	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	95 — 97	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	...	10½ — 11½	10½ — 11½	11⅛	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5½ — 6½	5½ — 6½	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅝ — 1⅞	1⅝ — 1⅞	1¾	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2 — 2¼	2 — 2¼	2⅛	2 1/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111	105 —110	106	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	13 — 14	13 — 14	...	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½ — 6	5½ — 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	8½ — 8¾	8½ — 9	8 1/16	8½
78,703	Do. do. Pref. half-shares	5	...	...	...	4½ — 5	4¾ — 5¼	5	...
78,703	Do. do. Def. do.	5	...	...	...	3¼ — 3¾	3¼ — 3¾	3 9/16	...
855,000	City and South London Railway	Stock	2⅛ %	1⅝ %	1¼ %	52 — 56	52 — 56	54	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4½ — 5½	4½ — 5½	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½ %	...	3½ — 4	3½ — 4	3 11/16	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —103	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1⅝ — 2¼	1⅝ — 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3½ — 4½	3½ — 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	88 — 90	88 — 90	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅞ — 2⅛	1⅞ — 2⅛	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½ — 3	2½ — 3	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104 xd	101 —104	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	...	13½ — 14½	13½ — 14½	14⅜	13¾
30,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½ — 6	5½ — 6	5⅝	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½ — 21½	20½ — 21½	21¼	20⅞
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	102	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½ %	3¾ %	...	8⅞ — 8⅞	8⅞ — 8⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	...	13¼ — 13½	13¼ — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	...	38 — 42	38 — 42	...	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	... %	...	100 —103	100 —103	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	10 — 11	10 — 11	10¼	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	...	94 — 97	94 — 97	96	94½

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 103—106.
Consolidated Telephone Construction and Maintenance, 3/—5/-
National Electric Free Wiring, 13/6 paid, ⅛—¼.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16—17.
Do. do. Pref. (£10 pd.), 10—10½.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11½—12½; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7½. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 16.

Bank rate of discount 5 per cent. (January 3rd, 1901).

MARKET QUOTATIONS, Wednesday, January 23rd.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3½d.	3½d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5s.	£6	5s. inc.
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8d.	8d.	..
c ,, Wire, basis	per lb.	8¾d.	8¾d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or
g Copper Sheet	per ton	£96	£96	..
g ,, Rod	per ton	£86	£86	..
e ,, (Electrolytic) Bars ..	per ton	£82	£82	..
e ,, ,, Sheets ..	per ton	£90	£90	..
e ,, ,, Rod ..	per ton	£84	£84	..
e ,, ,, H.C. Wire	per lb.	9¼d.	9¼d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/8½ to 3/9	3/8½ to 3/9	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	47/3	48/5	1/2 dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10 10	£10 10	..
g Lead, English Ingot	per ton	£15 17 6 to £16	£16 7 6 to £16 10	01s. dec.
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/8	From 1/8	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£127 to £128	£124 to £125	..
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals —				
"White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9¼d.	9¼d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4¾d.	4¾d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5¾d.	5¾d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne ond.)	per ton	£23 2 6	£23 2 6	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yee & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

DUTIES ON ELECTRICAL GOODS FOR THE COLONIES.

To the *Board of Trade Journal* we are indebted for the following Table showing the rates of Customs duties leviable on electrical machinery and apparatus in India and the undermentioned British Colonies, revised in accordance with the latest information in the possession of the Department, which has been prepared by the Board of Trade:—

Colony, and tariff classification.	Rates of duty.
*BARBADOS—	
All kinds	15 per cent. *ad val.*
BRITISH GUIANA—	
Machinery and wire for electric lighting	Free.
Machinery and apparatus for the original construction of an electric tramway in Georgetown, by the Demerara Electric Company, Limited.	,,
Other machinery	Part free, part 15 per cent. *ad val.*†
Implements for electric lighting, imported by the Mayor and Town Council of Georgetown or of New Amsterdam, for lighting any street or place belonging to them, or subject to their control.	Free.
Telegraph instruments and other materials imported by Telegraph Companies and necessary for the construction and use of their works, offices, and stations in the Colony.	,,
Other	15 per cent. *ad val.*†
‡CANADA—	
Glass bulbs for electric lights	10 ,, ,,
Electric or magnetic machines for separating or concentrating iron ores.	Free.
Telephone or telegraph instruments, electric and galvanic batteries, electric motors, generators, dynamos, sockets, insulators of all kinds, and electric apparatus not elsewhere specified.	25 per cent. *ad val.*
Electric light fixtures, or metal parts thereof, including lava or other tips, collars, galleries, shades, and shade holders.	30 ,, ,,
Carbons over 6 inches in circumference	15 ,, ,,
Other electric light carbons and carbon points of all kinds	35 ,, ,,
Electric belts	20 ,, ,,
Steam and portable engines, boilers, and machinery, composed wholly or in part of iron and steel.	25 ,, ,,
Wire, single or several, covered with cotton, linen, silk, rubber, or other material, including cable so covered.	30 ,, ,,
Other wire cable and stranded or twisted wire	25 ,, ,,
Copper wire, plain, tinned, or plated	15 ,, ,,
Platinum wire	Free.
CAPE OF GOOD HOPE—	
Machinery to be driven by electric power (including spare parts), and apparatus and appliances used in connection with the generating and storing of electricity, but not including electric cable, or wire, or the posts for carrying the same, and not including lamp-posts, lamps, or their fittings.	Free.
Telegraphs and telephones; materials and instruments for use in construction and working of telegraph and telephone lines.	,,
Other	7½ per cent. *ad val.*§
CEYLON—	
Prime movers and machinery (and component parts thereof), meaning machines or sets of machines to be worked by electric power. Provided that only such articles shall be admitted as component parts of machinery as are indispensable for the working of the machinery, and are, owing to their shape or to other special quality, not adapted for any other purpose. *Note.*—Machinery and component parts thereof made of substances other than metal are included in this entry.	Free.
Instruments, scientific, or if intended for the professional use of passengers.	,,
Other	5½ per cent. *ad val.*
INDIA—	
Prime movers and machinery (and component parts thereof), meaning machines or sets of machines to be worked by electric power.	Free.
Dynamos, accumulators, motors, and electric fans Provided that only such articles shall be admitted as component parts of machinery as are indispensable for the working of the machinery, and are, owing to their shape or to other special quality, not adapted for any other purpose. *Note.*—Machinery and component parts thereof made of substances other than metal are included in this entry.	,,
Other (except telegraphic instruments and apparatus, and parts thereof, when imported by or under the orders of a railway company, or instruments, apparatus and appliances when imported by a passenger as part of his personal baggage and in actual use by him in the exercise of his profession or calling, which are free)	5 per cent. *ad val.*
JAMAICA—	
Apparatus and appliances of all kinds for generating, storing, conducting, converting into power or light and measuring electricity.	Free.
Telephones and telephone switchboards	,,
Other	16⅔ per cent. *ad val.**
MAURITIUS—	
All kinds	10 ,, †
NATAL—	
Machinery to be driven by electric power (including spare parts), and apparatus and appliances used in connection with the generating and storing of electricity, but not including electric cable, or wire, or the posts for carrying the same, and not including lamp-posts, or lamps, or their fittings.	Free.
Telegraphs and telephones; materials and instruments for use in construction and working of telegraph and telephone lines.	,,
Other	7½ per cent. *ad val.*‡
NEWFOUNDLAND—	
Telegraph and telephone instruments, electric and galvanic batteries.	30 ,, ,, §
Electric motors, dynamos, generators, and sockets	20 ,, ,, §
Electric light fixtures or metal parts thereof, including lava or other tips, burners, collars, galleries, shades, and shade holders; lamp springs and glass bulbs; electric meters; carbons and carbon points, and electric light material of every description.	30 ,, ,, §
Insulators and other electrical apparatus	20 ,, ,, §
Copper wire	30 ,, ,, §
NEW SOUTH WALES—	
All kinds	Free.
NEW ZEALAND—	
Electric machinery and appliances, including electrical hoists, electric light apparatus for dredging plant, electromotors, hand dynamos, and electric fans.	10 per cent. *ad val.*
Engines for electric lighting machinery	20 ,, ,,
Electric cooking or heating apparatus	20 ,, ,,
Brackets, standards, electroliers, and other fittings for distributing the light.	20 ,, ,,
Lamps and lanterns	20 ,, ,,
,, arc	10 ,, ,,
Globes, shades, and chimneys: glass or metal	20 ,, ,,
Telephones	Free.
Electrical apparatus for surgeons' use	,,
Electric batteries and motors for dentists	10 per cent. *ad val.*
,, belts, other batteries and magneto-electric machines.	20 ,, ,,
Electric bell fittings (except cells for batteries, 10 per cent.).	20 ,, ,,
Electric pens and duplicating presses	20 ,, ,,
Earthen and stone ware, china and porcelain	20 ,, ,,
Copper wire	Free.
NORTHERN TERRITORY OF SOUTH AUSTRALIA—	
Telephones	,,
Gas and portable engines	,,
Other engines and parts	15 per cent. *ad. val.*
Bells; china, stone, glass and earthenware; lamps and lampware	15 ,, ,,
Copper wire	Free.
Other	10 per cent. *ad. val.*
QUEENSLAND—	
Electric machines, machinery and fittings	Free.
Machinery for telegraphic purposes	,,
Gas and portable engines	,,
Copper wire	,,
Insulating materials	,,
Batteries and galvanic belts for surgeons' use	,,
Lamp globes	15 per cent. *ad. val.*
Other	25 ,, ,,
SOUTH AUSTRALIA (except Northern Territory)—	
Copper wire	Free.
Batteries for telephones, telegraphs, and medical use	,,
,, other	20 per cent. *ad. val.*
Telephones	Free.
Engines, portable and gas	,,
Other engines and parts thereof	25 per cent. *ad. val.*
,, machinery	20 ,, ,,
Electric bells and bell indicators	25 ,, ,,
,, switches and cut-outs	15 ,, ,,
Glassware, cut, engraved, etched or ground	20 ,, ,,
Other glassware and globes, and carbons for electric lighting.	15 ,, ,,
Brown earthenware and stone ware	20 ,, ,,
Other earthenware and china ware	15 ,, ,,
,, fittings or appliances unenumerated	10 ,, ,,
STRAITS SETTLEMENTS—	
All kinds	Free.
TASMANIA—	
Engines, engine fittings and electric machinery of all kinds.	10 per cent. *ad val.*
Electric light main cable, transformers connected therewith, and insulators for main cable.	10 ,, ,,
Other	20 ,, ,,

*The Tariff Act imposing the duties in Barbados lapsed on December 31st, 1900. No later information has been received.

† Subject to a deduction of 5 per cent. on the duties leviable at the rates given, provided the Reciprocal Trade Convention between Great Britain and the United States in respect of British Guiana does *not* come into operation.

‡ In accordance with the provisions of the British Preferential Tariff of 1898, as amended in 1900, articles which are the manufacture of the United Kingdom, Bermuda, British West Indies, British Guiana, British India, Ceylon, Straits Settlements and New South Wales, when imported direct from any of such countries, are entitled to a reduction of *one-third* of the duty.

§ A rebate of *the whole* of the Customs duties is allowed on the following goods imported into the Cape of Good Hope on their removal to places *other than* Natal, Orange River Colony, Basutoland, and the Bechuanaland Protectorate, provided such places are open for trade, viz.:—Electric cable or wire and posts for the same, and their fittings; electric lamp-posts and their fittings; electric lamps and switches, not including fancy or ornamental lamps, switches and fittings for indoor lighting; and signalling wire, bells and gongs, for use in or about mines.

On *other* dutiable goods a rebate of 4½ per cent. is allowed.

Goods imported into the Cape of Good Hope for removal overland to Natal, Orange River Colony, Basutoland, and the Bechuanaland Protectorate, pay the same rates of duty as if for the Cape of Good Hope.

* Telegraph materials imported into Jamaica by the International Ocean Telegraph Company, or by the Direct West India Cable Company, free.

† With an additional charge of 10 per cent. on the duty leviable on goods imported into Mauritius on or *before* December 31st, 1900. The rate of exchange at which the value of goods coming from the United Kingdom shall be declared for the purpose of levying *ad valorem* duty thereon was fixed at 15 rupees to the £ sterling for 1900.

‡ A rebate of *the whole* of the Customs duties is allowed on the following goods imported into Natal on their removal overland to places *other than* Cape Colony, Orange River Colony, Basutoland, and the Bechuanaland Protectorate (provided such places are open to trade), viz.:—Electric cable, or wire, and posts for same and their fittings; lamp-posts (electric), and their fittings; electric lamps and switches, not including fancy or ornamental lamps, switches and fittings for indoor lighting; and signalling wire, bells and gongs for use in and about mines.

On *other* dutiable goods a rebate of 4½ per cent. is allowed. Goods imported into Natal for removal overland to Cape Colony, Orange River Colony, Basutoland and the Bechuanaland Protectorate pay the same rates of duty as if for Natal.

§ With an additional charge of 10 per cent. on the duty leviable at the ra given.

Colony, and tariff classification.	Rates of duty.
TRINIDAD AND TOBAGO—	
Machinery	Free.
Other	5 per cent. *ad val.**
VICTORIA—	
China ware, earthenware, and porcelain, being telegraphic materials.	Free.
Globes and telegraph glassware, cut, embossed, &c.	2s. 6d. per cubic foot.†
" " uncut, &c.	1s. " " †
Other glassware	25 per cent. *ad val.*
Electric wire (covered or uncovered)	Free.
Electrical apparatus	"
Electric fittings, viz., arc lamps without globes, carbons, incandescent lamps, automatical resisters, transmitters or transformers, and storage batteries.	"
Bell fittings	"
Bells (6 inches and under)	"
Lightning conductors	"
Metal manufactures (including galleries for electric lamp sockets and for incandescent lamps, whether attached or not, electric staples and fittings for pipes and tubes).	30 per cent. *ad val.*
Electroliers	33 "
Machines and machinery for telegraphic purposes (but not including the motive power thereof).	Free.
Other machinery, including electric motors (except for dental purposes, free).	25 per cent. *ad. val.*
Engines (other than portable)	30 " "
Portable engines	15 " "
WESTERN AUSTRALIA—	
Machinery	5 " "
Parts of machinery	10 " "
Electric batteries and meters (including Kelvin and volt) and galvanometers.	10 " "
Lamps and lampware	10 " "
Other electric light material, electric bells (except for telegraphs and telephones), and cables.	5 " "
Earthen, glass, stone, and china ware, not otherwise enumerated.	15 " "
Electric lau-ches and electric bronzes (including lamps attached).	20 " "
Telegraph and telephone materials, including instruments.	Free.
Copper wire, and platinum wire and foil	"

Note.—In the traffics of several of the Colonies dealt with in this table there is no separate reference to *electrical* machinery and apparatus. In such cases the rates of duty are given for those classes of articles with which the various kinds of electrical machinery and apparatus would probably be grouped, but it is not always certain how the tariff would be interpreted by the loc l Customs authorities.

* Goods for the use of the bureau for meteorological observations maintained in Port of Spain by the United States Government, free.

† Including packing (measuring outside the package as imported).

INSTITUTION OF ELECTRICAL ENGINEERS.

CAPACITY IN ALTERNATE CURRENT WORKING.

By W. M. MORDEY, Member of Council.

(*Paper read January 10th*, 1891.)

THIS is an attempt to consider some of the effects of electrostatic capacity in insulated cables for alternate current working, especially as regards the power and plant.

Distinctions formerly drawn between "current electricity" and "static electricity" have left impressions on our minds by no means helpful now. When we come to deal with electrostatic capacity in engineering applications with rapidly alternating currents, we find that so far from being "static" the conditions and effects are those of current or flow, and may most usefully be studied as such.

Electrostatic capacity in cables in some respects is an advantage, but on the whole, it is a serious drawback in alternate current work, mainly because it is directly and indirectly a cause of waste of power.

Now that many applications of extra high tension alternate current distribution are being promoted, it may be useful to carefully examine what is involved in this property as regards the power and plant required.

In attempting to do this I may be allowed to begin at the beginning, as I think this may be useful to many engineers who have not hitherto considered the subject in its relation to economy of working.

The capacity of a cable is measured usually by comparing it with that of a standard condenser, using a low pressure and observing the throw of a ballistic galvanometer.

The unit of capacity is the farad, but as it is too large for practical purposes, the practical unit adopted is the microfarad or $\frac{1}{1000000}$ of a farad.

Electric supply cables have a capacity varying from about one-fifth of a microfarad to about one microfarad per mile, according to the size, the form, and the kind of insulating material used.

If two cables are connected to the terminals of an alternator, a current to charge the cables will flow into them as the pressure rises in each half period, and back again as the pressure falls. As this occurs usually from 100 to 200 times a second it is of course just as "continuous" as any other alternating current. The amount of this charging current is easily found if we know the capacity of the cable.

Perhaps I may be allowed to give a practical idea of what a microfarad is, in terms of volts, amperes, and periods.

The capacity current in amperes

$$= \frac{\text{volts} \times \text{periods per second} \times \text{microfarads} \times 2\pi}{1{,}000{,}000}.$$

Take an illustration from ordinary familiar working conditions in order to fix in the mind a quantitative idea of this:—

One microfarad takes 0·6283 *ampere at* 2,000 *volts* 50 ~.

The above expression assumes that the capacity is independent of the pressure.

In order to satisfy myself on this point I was able, by the kindness of Mr. Gray and the Silvertown Company, to make some tests on some rubber cable in the tanks at the Silvertown Works. The alternator ran at 90 ~, and the pressure was varied from 2,000 to 5,000 volts. The following readings were obtained:—

Volts.	Amperes.
2,000	0·62
2,500	0·75
3,000	0·97
3,500	1·11
4,000	1·29
4,500	1·45
5,000	1·65

These results, which are plotted in fig. 1, show that the current is simply proportional to the pressure, and therefore that the capacity is not affected by the pressure.

I may here draw attention to the ease with which capacity measurements of systems of mains may be taken. It is a measurement that is, I think, never taken by station engineers.

Knowing the E.M.F. and the periodicity, it is only necessary to take the current. Then

$$\frac{\text{Amperes} \times 1{,}000{,}000}{\text{Volts} \times \sim \times 2\pi} = \text{microfarads}.$$

If the tests are always taken at one E.M.F. and periodicity, the scale of the ammeter may be marked to read directly in microfarads. This method is of course merely according to the "Ohm's law" of the subject, but it does not appear among those given in standard works on the subject. As it can be applied wherever an alternator is available, it should be useful to station engineers and others, especially for taking the capacity after the mains have been laid. The test can be made at the full working pressure—and variations of capacity with age may be easily observed.

In order to show what the capacity current may amount to in practice, I have worked out the following table for a length of cable having a capacity of one microfarad.

The capacity current is directly proportional to the pressure and to the periodicity.

The "apparent watts," or the amperes multiplied by the volts, are proportional to the square of the pressure for any given periodicity.

The table gives the current taken at various pressures by a cable of one microfarad at 50 ~, also the apparent watts taken and the apparent H.P. Another column, to be referred to later, gives the true watts.

TABLE I.—CAPACITY LOSSES IN CABLES.

Capacity Current, Apparent Energy, and Actual Energy required by a Cable of 1 *microfarad at various E.M.Fs.*, 50 ~

Volts.	Amperes.	*Apparent watts.* V × A.	*Apparent H.P.*	True watts. V × A × ·124.
1,000	0·314	314	0·42	39
2,000	0·628	1,256	1·69	156
3,000	0·942	2,826	3·8	350
4,000	1·256	5,024	6·7	623
5,000	1·57	7,850	10·5	973
6,000	1·88	11,300	15	1,400
7,000	2·2	15,400	20	1,910
8,000	2·5	20,100	27	2,490
9,000	2·83	25,430	34	3,150
10,000	3·14	31,400	42	3,890
15,000	4·62	69,300	93	8,590
20,000	6·28	125,600	166	15,570
25,000	7·85	196,000	263	24,300
30,000	9·42	282,600	380	35,040
35,000	11	385,000	516	47,730
40,000	12·56	502,400	679	62,300

Fig. 2 is plotted from this table, the upper curve giving the apparent power, and the lower curve the true power. Fig. 3 is the lower part of fig. 2 drawn to a larger scale.

At 100 ~ the current and watts would be double, and at 25 they would be one-half of the values given in the table.

When it is remembered that large distribution systems working at 10,000 to 20,000 volts may, and probably often will, have cables the capacity of which may be scores of microfarads, it will be realised that the magnitude of the capacity effect is considerable. Even at low and moderate pressures it is by no means negligible.

The term "apparent watts" is rather unsatisfactory. It is generally used to indicate that the whole of some volt-ampere quantity is not true watts, but it is sometimes applied to volt-amperes that are not watts at all. For instance, people will say, "So many true watts and so many apparent watts." The safest plan seems to be to use the term "apparent watts" as including both true and false watts, adding the power-factor, when known, to show how many of the apparent watts are true and how many are false.

The next question to consider is: What is the power-factor of the cables? This is very important, for whatever we may be able to accomplish in neutralising or compensating the charging current, so

far as I know we can do nothing to reduce the true watts absorbed by the dielectric of any given cable at any given pressure and periodicity. These true watts are made up of ordinary copper loss or C^2R due to any charging current flowing in the conductor, to leakage, and to dielectric hysteresis.

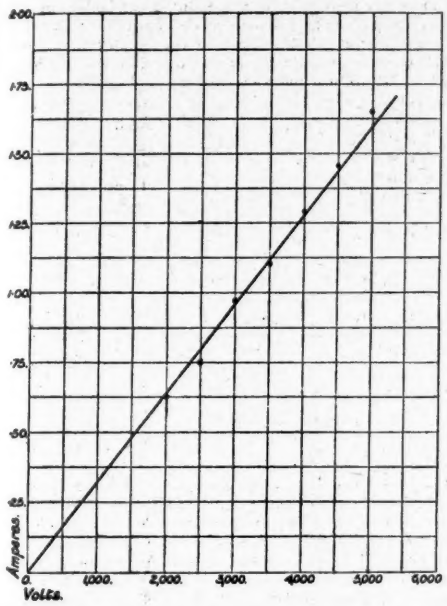


Fig. 1.—Capacity Current taken by Cable at Various E.M.Fs., 90 ~.

The C^2R loss due to the passage of the capacity current is usually unimportant, at least in large cables. It is easily calculated.

The leakage is also usually unimportant. Thus if a 2,000-volt cable has an insulation resistance of, say, 1,000 megohms per mile,

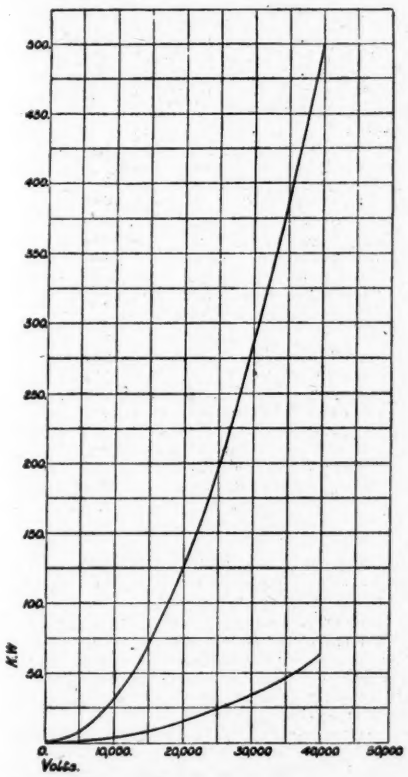


Fig. 2.—Apparent and real kw. taken by Cable of 1 Mfd. at various E.M.Fs., 50 ~.

Upper curve = apparent kw., lower curve = real kw.

the leakage will be only 2 millionths of an ampere and 4 thousandths of a watt per mile.

Then there is the loss from dielectric hysteresis; that is, the loss of energy due to the insulating material being subjected to rapidly repeated and violent electric strains.

Whether this effect is simply due to mechanical friction caused by rapidly repeated attractions and repulsions between the particles of the insulating material, and between that material and the metal within it and outside of it; or whether it is due to some more obscure molecular or polarisation effect, I do not know. A simple explanation is to be preferred if a satisfactory one can be got. From what we can observe of actual mechanical vibration it seems possible that the first-mentioned cause is sufficient to account for the loss.

But how much is this loss?

By the kindness of Mr. Sparks and the County Company I have been enabled to make some tests on this and other points.

The cable placed at my disposal was 5½ miles of 37/15s concentric rubber covered. It was steel sheathed, drawn into 2-inch cast-iron

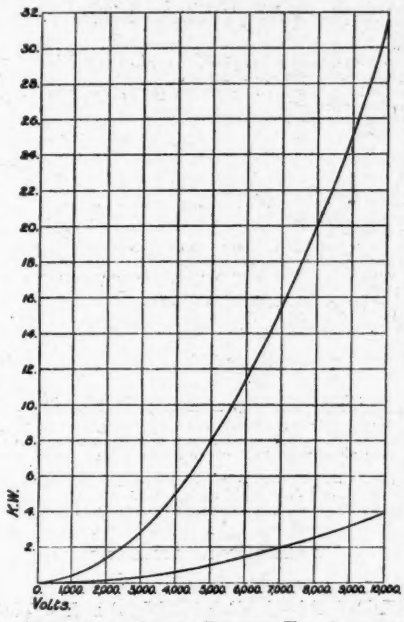


Fig. 3.—(This is the Lower Part of Fig. 2 drawn to a Larger Scale.)

Upper curve = apparent kw., lower curve = real kw.

pipe—the outer conductor was earthed, and the steel sheathing also earthed every 220 yards by stranded copper cables bolted to the iron pipe.

This cable was intended to be used at 6,000 volts 50 ~, but my test was made at 2,050 volts 100 ~.

The makers' test gave the capacity as follows:—

·86 microfarad between inner and outer, and
1·06 „ „ outer and earth.

As the outer was earthed, I need only consider the inner. The capacity current should be

$$\frac{2{,}050 \times 100 \times \cdot86 \times 5{\cdot}5 \times 2\pi}{1{,}000{,}000} = 6{\cdot}092 \text{ amperes.}$$

I found the actual current was 6 amperes—practically confirming the makers' test. It was interesting to find that a measurement made at a high E.M.F. and high periodicity gave the same result as a ballistic galvanometer test with a low E.M.F. The cable was run for several hours with a Thomson recording wattmeter in circuit, this instrument having been specially tested by the County Company at low power factors. The pressure was nearly steady at an average of 2,040 volts, the current being 6 amperes. The apparent watts were therefore $6 \times 2{,}040 = 12{,}240$.

The true watts, by the wattmeter, were 1,515, or 275 watts per mile.

The power factor $= \frac{1{,}515}{12{,}240} = 0{\cdot}124$; that is to say, the true watts were 12·4 per cent., or about ⅛th of the apparent watts.

The C^2R* and the leakage were both negligible, so the whole of this loss was due to dielectric hysteresis.

It cannot be said that 2,226 apparent watts and 275 true watts per mile are negligible quantities. This is at 2,000 volts, 100 ~.

When the cable is worked as intended at 6,000 volts, 50 ~, the losses per mile will be—

$\cdot86 \times 6{,}283 \times 3 = 1{\cdot}621$ amperes.

The apparent watts per mile $1{\cdot}621 \times 6{,}000 = 9{,}726$:

and the true watts $9{,}726 \times \cdot124 = 1{,}206$ per mile.

This of course is on the assumption that the power factor is the same at high pressures as at low (as seems probable), and that the loss in this instance was accurately determined.

The dielectric loss is not preventible. It may be lessened by

* The C^2R in this case = 13·4 watts.

increasing the thickness of the dielectric—that is, by reducing the strain—or by using a dielectric of low specific capacity, and by working at a low periodicity; but for any given case it must be accepted as one of the conditions of working. In some respects it is like the hysteresis loss accompanying the magnetising and demagnetising of iron.

But dielectric hysteresis seems to differ from magnetic hysteresis in showing no saturation effect. Possibly at very high pressures the curve may begin to bend down, but I should expect the insulation to break down earlier than the proportional law.

I have already said that the actual loss in the dielectric, whatever its amount, is going on always when the mains are energised—whether any power is being transmitted or not. In the case just examined of the 6,000-volt 50 ~ transmission it amounts to about 0·23 watt per foot of cable. So far as it is a cause of waste of power this may be, and often is, a much more important loss than the ordinary C^2R copper loss. This will be seen from the following comparison:—

The 37/15s cable (0·154 square inch) has a resistance of 0·271 ohm per mile, or 0·542 per mile for the two conductors. The constant dielectric loss of 1,206 watts per mile is therefore equivalent to a copper loss due to the constant passage through both conductors of 47·2 amperes, or at the current density of 326 amperes per square inch; (or in the single conductor 67 amperes = 460 amperes per square inch), or a current that would give a drop of 25·6 volts per mile, or 0·46 per cent. per mile on a 6,000-volt circuit. If the cable is in continuous use its dielectric uses up 10,564 B.T. units per mile per annum.

To further illustrate this loss I have worked out tables for 2,000 volts and 7,500 volts, taking five commercial sizes of concentric cables and giving the dielectric losses, and the copper losses that would be equivalent to those dielectric losses. I have taken the dielectric power-factor as 0·124 as before. This factor may, of course, vary with different cables.

TABLE II.—CABLES WORKING AT 2,000 VOLTS, 50 ~.

Losses in Dielectric per Mile.

Size of cable		17/20	19/20	19/16	19/14	37/16
Copper section: sq. in. ...		·007	·019	·060	·094	·118
Resistance		6·	2·213	·7	·45	·36
Capacity, mfd.		·33	·5	·6	·7	·75
Apparent watts		419	628	754	880	944
True watts		52	78	93	109	117
Current (and current density) in conductor that would give loss equivalent to that in dielectric	Amp.	2·95	5·95	11·55	15·6	18
	Amp. per sq. in.	420	312	192	165	153
B.T. units per mile per year		455	683	815	955	1,025

TABLE III.—CABLES WORKING AT 7,500 VOLTS, 50 ~.

Losses in Dielectric per Mile.

Size of cable		17/20	19/20	19/16	19/14	37/16
Mfd. per mile		·2	·33	·364	·425	·454
Apparent watts		3,300	5,450	6,000	7,000	7,500
True watts		410	670	744	870	930
Current (and current density) in conductor that would give loss equivalent to that in dielectric	Amp.	8·3	17·4	32·6	44	50·7
	Amp. per sq. in.	1,180	913	540	467	430
B.T. units per mile per year		3,590	5,870	6,520	7,630	8,147

NOTE.—In these two tables the equivalent copper loss is taken as that in a single conductor—not in a "lead and return"—for the reason that the dielectric loss is the same (for the same capacity) whether the main is a single one or double.

Take a higher pressure illustration. Imagine a system of 40 miles of cable working at 23,000 volts 50 ~, the capacity being 0·5 mfd. per mile. With no load and no apparatus connected to the mains, the generator would have to provide a charging current of 125·6 amperes at 20,000 volts = 2,512,000 apparent watts.

If the power factor is ·124, then the actual energy absorbed by the mains will be 311,488 watts, and the number of B.T. units consumed per year will be 2,728,633, or an annual output that is exceeded by only a very few electric supply stations in this country. The loss works out at 1·5 watts per foot of the cable.

One rather unfortunate property of cables is shown by these tables. I refer to the fact that as different sizes of cables, made systematically to be suitable for safely working at any given pressure, have capacities which do not lessen very much with decrease of size, the dielectric loss of small cables is therefore disproportionately large. For example, in the five sizes given, the section increases in the ratio 1 to 17, but the capacity only as 1 to 2·28.

The carrying power of a cable is limited in most cases by drop of volts rather than by heating or loss of power, otherwise this dielectric loss would very much restrict the load that could be put on cables.

Nevertheless, this loss seriously affects the question of raising the pressure for long distances or large powers, at least where underground or covered conductors have to be used. As the copper loss is inversely as the square of the current, the temptation is to increase the pressure and reduce the current. But the dielectric loss being proportionate to the square of the pressure, and being moreover a constant or all-day loss, whereas the copper loss is only fully felt at times of full load, limits to increase of pressure are imposed which may be reached sooner than has been supposed.

This opens a field for very careful consideration—and balancing of advantages—of high and low (or lower) pressure. I do not attempt to make any comparisons now. Every case must be examined on its merits and due weight given to load-factor, drop, value of power, plant capacity, and so on.

I believe the general opinion has been that the production of capacity current involved practically no expenditure of energy; that it was in reality a wattless current, and that the only waste—a sufficiently considerable one—was in running the alternator under light load. I think nothing contrary to this opinion was put forward before the recent Parliamentary Committees on Power Bills. Those committees were assured, for instance, that so far as power was concerned, the losses with underground cables were the same as with aerial lines. I fear this is by no means the case. I do not wish to adopt an alarmist tone on this subject, but I think it will be admitted that if the tests referred to above are even only approximately correct, the subject deserves the very serious consideration of electrical engineers.

It is probable that those who have had to do with extra high-tension mains, or even with long or extensive mains, working at moderate high pressures, will have noticed, as I have, that when switching such mains on, the engine has been checked much more than would be consistent with the production of merely wattless current.

(*To be continued.*)

INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW SECTION).

DISCUSSION ON MR. YORKE'S PAPER.

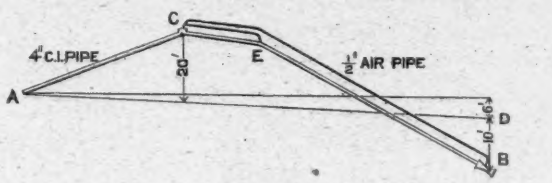
THE third general meeting was held in the smaller Hall of the Institute of Engineers and Shipbuilders, 207, Bath Street, on Wednesday, January 9th, Prof. Magnus MacLean in the chair. A paper (published in last week's ELECTRICAL REVIEW) was read by Mr. R. F. Yorke (Subject: "Practical Notes on Water-Power for Electrical Purposes") and the following discussion took place:—

Mr. WILLIAM MCWHIRTER, Member, in opening the discussion, said that he was afraid there was very little to discuss, and were he to say what he felt inclined to say he was afraid it would perhaps be displeasing alike to the author of the paper and the meeting. It was very natural for anyone who had the *Proceedings* of the Institution at hand to turn back for a few years, and doing this, he had been led to read a very admirable paper on "Turbines" in the volume of the *Proceedings* for 1896. In this paper every aspect of the very important question of turbines was entered into. In going over this paper, it had occurred to him that, seeing so many of the members of the Local Section of the Institution were young men, it would be a very good thing for them to ask the Parent Institution to supply their Section with a full set of the *Proceedings*, to be readily accessible to all the members and associate-members of the Glasgow Section. Anyone who had had anything to do with turbines must have come to the conclusion that the turbine invented by Sir (? Prof.) James Thomson in 1850 or 1851 was a most perfect machine. Those who had had the pleasure of working with that machine could not give it too high praise. With regard to the question of pipes referred to by Mr. Yorke, of course everybody knew that they were a very important factor in any water-power scheme, and were very often neglected or misunderstood. A paper read by Mr. Gale, of Glasgow, before the Institute of Engineers and Shipbuilders, some time ago, showed that not in the last but in the former scheme for bringing a water supply to Glasgow from Loch Katrine the formula used had been altogether out, and those who wished to go into calculating the dimensions, &c., for water schemes would do well to refer to that very excellent paper. It was clearly shown there that even up to two years ago the most experienced men in that work were altogether at sea as to what was the proper formula to be used in connection with water pipes. Concluding, the speaker said he had no doubt at all, that if their coal fields got worked out, and coal bills continued to go up as they had been doing, in the course of the next generation water would be a very important factor, and it would receive from electrical engineers that attention which it has not yet received.

Mr. RITCHIE, Edinburgh, Visitor, on the invitation of the chairman, said: I have listened with pleasure to Mr. Yorke's paper, and as a manufacturer of turbines, I am naturally interested in the development of water-power. There is no one better qualified to treat the matter well in all its bearings than Mr. Yorke, and I believe I am correct in stating that no other electrical engineer in Scotland has installed so many water-power plants for electric

lighting, many of them of considerable size. Mr. Yorke has spoken on the subject very generally, and I should have liked him to have given us a little more detail in connection with the running of water-power machinery, for the benefit more especially of the younger members of this Institution, who may have some difficulty in grasping principles involved in the application of turbines to electric lighting. Mr. Yorke has stated clearly the different types of turbines, and with most of his statements I am at one with him; as time is limited, I shall merely touch on one or two points. Mr. Yorke, in referring to suction pipes for turbines, stated that a pipe laid on a slope was a failure in maintaining a good vacuum; this I have proved, and I think Mr. Yorke's theory of the air bubbles to be the correct and generally accepted view. At the same time I understand that sloping suction pipes are used in America, but perhaps the turbines to which they are fitted work mostly at full load with the pipes running full, when there is less tendency to destroy the vacuum. I do not agree with Mr. Yorke in regard to governing turbines. I think every turbine ought to be fitted with a governor. A storage battery may in many cases be a necessity, and I know that where storage batteries are used it is generally considered that a governor is necessary, but, as every one knows, batteries have their weaknesses, and where the water supply is such that the turbine can be run continuously, I think it is to be preferred. Great improvements have been made in governors of late, and one of the most improved forms of governing turbines has been at work for the last two months night and day without attention, more than oiling, &c., driving a dynamo for lighting, heating, cooking, &c. The variations of load are considerable, but still there is a very small percentage of rise or fall in the voltage. Mr. Yorke has said there are no large transmission plants in this country, and when compared with those on the Continent and elsewhere this is true. The largest I know of is in Ireland, where at Milford, on the River Barrow, there are two 50-H.P. and one 80-H.P. turbines at work generating alternating current at 2,500 volts, which is sent into the town of Carlow, 5½ miles distant, where it is used for lighting and also for motors in several small industries. A contract has just been made for nearly 2,000 H.P. in the north of Ireland, and several thousand horse-power is being negotiated in the north-west of Ireland; people are now waking up to the fact that even in this country there is some prospect of useful work being got on a large scale from water-power. As Mr. Yorke is so well acquainted with the west of Scotland, the district of greatest rainfall, I am somewhat disappointed that he was not able to enlighten us on the prospects there for the utilisation of water-power on a large scale. Perhaps it is not generally known that some very high falls are already used for power. On the Ochils, near Stirling, there is a Girard turbine working under a head of 860 feet, and at Brora, in Sutherlandshire, there is a Pelton wheel working under 950 feet head, and these are only samples of what might be done all over the north and west of Scotland.

Mr. G. T. BLACKWOOD MURRAY, B.Sc., Member, said: I have listened with the greatest interest to Mr. Yorke's paper on "Water-Power," and I think he has brought forward some very interesting points. My father and I have had a fairly wide experience in designing and putting down water-power electric generating plant, and we have met with some of the difficulties with suction pipes which Mr. Yorke mentions in his paper. I do not think that for long suction pipes the plan suggested by Mr. Yorke, namely, of taking them out horizontally and then vertically downwards, would always be found satisfactory; although the air given out by the water due to the reduction of pressure below atmosphere would be carried along the level portion, it would almost certainly lodge just where the bend down occurred, as the speed of the air bells upwards in the vertical portion would be greater than the down velocity of the water, unless this latter were made fairly high by reducing the section of the vertical pipes. From experiments I have found that for every size and slope of pipe there is a certain speed at which bells of air travel along the pipe. It is evident, of course, that unless the speed of the water in the pipe be greater than this speed, the air will not be carried forward and discharged, but will lodge or travel back. I may quote as an instance a small turbine, which we put down in 1887. This was worked with 10 feet of head and a suction tail-race 180 yards long of 6-inch cast-iron pipe, having a gross fall of 19 feet. Of this 3 feet was lost by friction. The pipe was carried out nearly horizontal from the turbine, having, in fact, in the 180 yards, barely 3 feet of fall, and then had a vertical drop of rather over 13 feet. When started up the suction gradually rose to about 9 feet, but remained there, whereas 16 feet of suction ought to have been got. The velocity of the water in the pipes was 3 feet per second. To remedy matters we put on a butterfly type of foot valve at the outlet and a self-acting air valve just at the turbine. The suction pipe was then filled up before starting by turning on a small quantity of water and allowing the air to escape. The turbine was started by opening the foot valve and turning on full water. The full suction of 16 feet was then got, but after about eight hours' run this fell to about 14 feet, showing clearly that air was gradually gathering. In another case we put down a siphon to provide an auxiliary supply to a power plant, which had, I think, some novel and interesting features. It will be better understood by reference to the accompanying sketch. From the inlet, A, to the outlet, B, the length of the pipe was 480 yards. The siphon was 4-inch ordinary cast-iron pipe, and was designed to pass 9 cubic feet per minute. The fall from the inlet to the outlet is 16 feet. The loss by friction amounted to 6 feet. The line, A D, indicates the hydraulic mean. The height of the highest part of the siphon above the hydraulic mean is 20 feet. At the outlet of the siphon we passed the whole of the water through a simple form of ejector, or water jet air pump, as we called it. To work this jet pump we had a head of 10 feet, as will be seen by reference to the diagram. The *vena contracta* of the pump was 9 inches diameter, and the pump gave us a suction of 21 inches of mercury, or equal to 24 feet of water. From the jet pump a ½-inch pipe was led to an air vessel fixed on the highest part of the



SKETCH OF SIPHON.

siphon, and the pump proved far more than sufficient to pump out all the air either excluded by the water or leaking into the siphon. As a matter of fact, we several times let a large quantity of air into the siphon, but in a very few minutes the pump had cleared it out and was working with almost solid water in the ½-inch pipe. With the pump out of action, the siphon would only run about five hours; with the pump in action it ran two days and then stopped. On investigating the cause, it occurred to us that the nearly flat part of the siphon between C and E had not sufficient slope to ensure air bells, generated in that part, returning to the air vessel. This supposition we confirmed by experiment. To overcome this difficulty, an auxiliary air pipe was led from E and connected on to the other air pipe near C. All trouble then vanished. The siphon worked continuously without a hitch. I think that in many instances where it is at all important to get the full effect of the suction, it would be well worth the engineer's while to fit on a small jet pump, such as we used to keep the suction pipes clear of air and ensure the highest working efficiency. As to Mr. McWhirter's remarks on governing, permit to point out that the problem is a far more difficult question than that of simply moving the guide blades. There is the momemtum of the whole mass of water driving the turbine to be checked, and if this is attempted too rapidly, hunting is the result. The subject is much too large and intricate to be discussed at this meeting. With my patent turbine governor, however, as manufactured by Messrs. Gilbert Gilkes & Co., of Kendal, we have found it possible to govern within 2 per cent. from no load to full load. I may mention that these governors are fitted on the eight turbines used for the lighting of the town of Launceston, Tasmania.

Mr. W. A. CHAMEN, Member, asked if Mr. Yorke would be good enough to explain in his reply whether the turbines at Chèvres maintained their load even with so large a variation in the head as 50 per cent. Mr. Yorke had stated that they maintained the speed, but he presumed that they could not maintain the same load. He also asked why, if the air bubbles destroyed the vacuum with an inclined suction pipe, they did not act in the same way with a vertical suction pipe. With regard particularly to the question of governing as applied to turbines, used for private house installations, he described the turbine and dynamo plant put down at Braemore, Ross-shire, for the late Sir John Fowler. The head of water available was about 200 feet, being obtained from a reservoir away up the side of the mountain right above the house. The turbines were fixed in part of the kitchen premises of the house itself. They were of Messrs. Gilkes' make, and of the vortex type, three in number, each being of 12 H.P., and running at a speed of 1,200 revolutions per minute, and each being coupled direct to a Crompton dynamo. The governing was managed by a Willans electric governor, consisting of a shunt solenoid, working a water relay, which controlled the supply to a powerful hydraulic ram, arranged so as to open and close the guide blades of the turbine, an operation requiring a considerable amount of power. No accumulators were used, and the governing proved extremely successful, the only trouble being that at first the delicate water relay valve got choked by some of the peatty matter from the water. This was remedied by inserting a fine filter, which however itself became choked after a few days' run, and required frequent changing of the filter papers. There being no accumulators, a novel device in the shape of an alarm clock, arranged to open the connection to a hydraulic cylinder working a sluice valve, was fitted so that everyone, including the attendant, could retire to bed leaving the plant running. When the desired time arrived the clock turned on the water to the cylinder, which, however, was only allowed to pass very slowly through a small-bore cock and pipe so as to ensure a very gradual shutting down of the plant, giving notice by the dimming of the light to any persons who might not be already in bed that the supply would absolutely cease within about a quarter of an hour, thus giving them time to be fully prepared before the final extinction. The installation was carried out something like 15 years ago, and he had not heard anything of it lately. He much regretted the absence of Mr. Sam Mavor, who, he knew, had dealt with it from time to time since it was first put down, and who might have been able to give some further interesting information respecting it.

Mr. J. M. MUNRO, Member, said: Mr. Yorke has said that water-power is an interesting subject, and that for two reasons:—(1) Because of the variety of problems presented in practice by diverse conditions. (2) Because of a partial analogy between hydraulic and electric laws. His theme and its treatment suggests, although it does not state, that there is a hydraulic analogue to the writing of a paper for this Association. To get power in a paper there is needed not only a smooth flow of words but also an *effective head*. Nor does the paper lack that other source of interest arising from

diversity. But the most striking feature of the paper—as of water-power plant—is its simplicity. The author has not harassed our minds with novelty of methods nor with definite details of results, nor yet with great projects for harnessing for useful work the local results of the evaporative energy of the sun. His praiseworthy aim evidently has been to encourage even the youngest of his audience by a revelation of the simple, not to say obvious, maxims which guide much not unsuccessful practice in water-power engineering in this country. One could have wished, however, for more definiteness in the numerous asides referring to the author's own experience. Some of these were interesting and useful, but less so than if figures had been furnished. To take the first of them as a sample: when Mr. Yorke states that he has improved the efficiency and added to the power of many water-wheels by reducing their speed, it would have added usefulness to the remark if he had given details explaining the conditions and the ascertained sources and accounts of loss and of gain. In dealing with calculations regarding the best size of pipe, Mr. Yorke recommends a certain velocity of flow in the pipe. He certainly refers to the length of pipe line as something which should also be taken into consideration, but this length is the really important factor. There are places where it would pay to greatly exceed the recommended velocity; there are places where its adoption would ruin the scheme. The method used in some offices is this:—A diagram is prepared once for all from the familiar formulæ, which shows at a glance the loss of head per yard with any ordinary quantity of water and size of pipe. With this it is easy to compare costs and losses, and rapidly to select the right pipe. Some such diagram would have been a useful addition to the paper, and quite in keeping with its scope. I do not notice on the walls any drawing of the specially interesting turbines of Chèvres, to which Mr. Yorke referred. The author of the paper has had much experience of suction pipes. Perhaps in his reply he will say what is his opinion as to the advantage of gradually widening the lower end of such tubes so as to reduce the velocity of exit. This has been recommended by some engineers, but more figures of actual trial are wanted. The opened soda-water bottle serves very well Mr. Yorke's purpose of illustrating how bubbles of air are given off under the reduced pressure in the suction pipe. His improved results got by carrying suction pipes horizontally, and then vertically, rather than on an incline, are worthy of note and experiment by other engineers. As to the cause of the improvement, one speaker has suggested that it is due to the velocity of water in the vertical portion, where alone, under Mr. Yorke's arrangement, air bubbles have a tendency to travel up the pipe. This speaker reminded us that at a certain "critical" speed the velocity of the water exceeds the speed of the ascent of the air bubble relative to the water, and so the air bubble is carried forward and out. This point also seems worthy of attention in laying pipes, especially near the top of the whole pipe line, and also just below the turbine, where the pressures are lower and air bubbles are more freely evolved. In Mr. Yorke's arrangement the horizontal water has almost the same velocity as the sloping or the vertical, but as the pipe forms a horizontal water plug against the ascent of air from the lower parts, it also bears away air bubbles brought down from above. For if any air leaves the water it only lodges on the surface of the water, reducing the area and quickening the speed. So any enlargement of suction pipe may be a mistake if it slows down water below this "critical" speed. A greater drop than 25 feet in a suction pipe does harm, chiefly because a too far reduced pressure below the turbine blades facilitates the escape of occluded air from the water, while anything approaching a vacuum might even draw in air through the turbine shaft and its journals or elsewhere, according to design. Of course, were it not for inwards air leakage, occluded air carried down, air bubbles, and air admitted by an insufficiently covered discharge pipe, any reasonable addition whatever to the usual 25 feet of vertical length of suction pipe would do no harm if it could do no good, beyond 34 feet. Doubtless Mr. Yorke has records of pressures in suction pipes, as ascertained by gauges at several points under various working conditions. In this matter, as in so many others in his paper, a few figures would have been a useful addition to the statements made. But after all, Mr. Yorke has given us a number of opinions, formed or endorsed by him as the result of extensive experience in his subject, and the paper is to that extent valuable.

Mr. GEORGE A. CLARKE (visitor), speaking at the request of the chairman, said he had not intended to make any remarks. In the subject before them there was ample opportunity for engineers, especially electrical engineers, to get a little further ahead than they were. He thought Mr. Yorke had not given them all the information he could have done. Perhaps Mr. Yorke did not wish to give it all away. He had not given them any information as to what could be done in the way of compounding dynamos when the water is a good bit away from the house. He thought if Mr. Yorke had given them more particulars regarding what he had done in getting over the great number of difficulties which always crop up in water jobs instead of giving them so much elementary matter with regard to the water-wheels and turbines, the paper would have been very much more useful.

Mr. YORKE, in reply, said: I have, in the first place, to thank the members for the kind manner in which they have received the paper read by me, and I think that all will agree that the discussion has been a most interesting one. I only propose briefly to touch on some of the points raised, as I think, in a general way, the various speakers have answered each other. There are a few points raised, however, to which I should like to refer. Mr. McWhirter was inclined to doubt that it was possible to run an electric light installation working under the continuous system described in the paper, but I can only reply that such a system is and has been in use for a great number of years without any of the troubles anticipated by him having arisen. It must be pointed out, however, that when a charging current is spread over 24 hours, instead of the ordinary 6 or 8 hours, that the charging current is, of course, reduced to one-third or one-fourth, and that it is found that when charging continuously at this low rate the variation in pressure is only slight. On the other hand, as pointed out in the paper, the lifetime of the accumulator is greatly prolonged. I was very pleased to hear Mr. Ritchie's remarks, as he has had so much experience in water-power in this country, and I was glad to hear that he and others are quite satisfied with the possibilities of effectually governing turbines. Mr. Murray's remarks on the same subject were also interesting, as I know he has given considerable attention to the matter, which involves many difficulties. Many of the members referred to the question of suction pipes alluded to in the paper. This subject is a very interesting one, and had space permitted, it is one which I should liked to have dealt with at greater length. Mr. Chamen asked a very natural question as to the reason of air troubles arising with a suction pipe laid on the slope, when no such air troubles appear when the pipes are laid vertically. My explanation is that when the pipes are laid vertically, the velocity of the downward current of water is greater than the upward velocity of air bubbles, and therefore it is impossible for air to accumulate at the top of the suction pipe. The result to be deduced from this theory is fully confirmed by the fact that suction pipes of too large a diameter do not answer, and recently a case was reported to me where suction pipes too large in diameter had had to be taken up and replaced by those of smaller diameter. Mr. Murray was under the impression that under my system of laying the suction pipes horizontally and then vertically there will be a tendency for the air to collect at the bend, but in practice I can assure him that such an effect does not occur, and that the same vacuum is obtained as if the pipes were fixed vertically. Both Mr. McWhirter and Mr. Chamen refer to Mr. Steiger's paper read before the Institution some years ago, and briefly referred to in my paper. That paper was a very interesting one, and should be read by all those interested in water-power questions; but it is solely dedicated to the question of turbines for low falls, with special reference to the class of turbine used so successfully by the Swiss firms, of which Mr. Steiger is the English representative. Mr. Chamen asks whether, while maintaining the speed of such turbines as those in use at Chèvres, the full power also is maintained, but I understand that such is not the case. With a full fall of 30 ft. 1,200 H.P. is obtained and 800 H.P. with a reduced fall of 15 feet, the speed of 80 revolutions being maintained. Mr. Field criticised the paper as wanting in figures, but this question has been so very fully dealt with in the engineering and electrical papers lately by Mr. Kershaw that it was unnecessary for me to add more, and I can only refer those anxious for figures to the articles mentioned. They will find that a very full comparison has been made of the cost of water-power as against steam and gas engines, both with reference to the original outlay and the annual costs.

LIQUID FUEL.

MR. E. L. ORDE'S paper before the North-East Coast Institution of Engineers on "Liquid Fuel" is full of useful figures. The last few years have seen a great development in the liquid fuel industry. Oil has been found along the Eastern Steamship route, beyond the Caspian area. Timor and Borneo both yield oil. The crude Borneo oil contains:—

Carbon	87·90 per cent.
Hydrogen	10·78 „
Oxygen	1·24 „

It has a flash point of 211° F., a boiling point of 395°, and a calorific capacity of 18,831 B.Th.U.; it is clean and mobile, and with so high a flash point is safe in use. If boiled, a residue of solid carbon is very apt to deposit in pipes and passages. In burning liquid fuel, full efficiency can only be obtained in a refractory lined furnace which will vaporise the oil. Borneo oil will raise 12·5 lbs. of water at 212° to steam at 212° per lb. of oil, showing an efficiency of 64·6 per cent. These results are obtained with a purely mechanical spray.

With steam or air-produced sprays, the oil is better divided into fine particles, and as much as 13·14 lbs. of water has been evaporated. When the oil is actually vaporised, as has been tried in retorts maintained at a red heat with steam-projected sprays, the retorts are apt to clog up with solid carbon.

In the presence of superheated steam these oils will fractionally distil without cracking. This is said to be due to the effect of the steam in lowering the boiling point—*i.e.*, more correctly speaking, the mean boiling point. This distillation, however, does not appear to be possible with any medium other than steam, and the oil must be nearly boiling before steam is admitted, wherein lies the danger of cracking taking place.

The vapour thus produced can be completely oxidised by the amount of air chemically necessary. Here, for example, is an analysis of waste gases from oil combustion which proves this to be the case, except so far as there is some uncombined oxygen, pointing to a slight excess of air:—

Carbon dioxide	13·2 per cent.
Oxygen	3·6 „
Nitrogen	83·2 „

Hydrocarbon vapour is very unstable, and depends entirely on high temperature for its existence. It is milky white, of pungent odour, and very irritating if inhaled. At 60° it is almost impossible to

ignite it, but it burns with brilliance in the presence of hot bricks, and the inference is that the vapour is first converted into acetylene by the temperature of 1,000°, and first burned as such. The loss of fresh water due to using superheated steam is, of course, a disadvantage on board ship, but the author thinks it more than balanced by the greater efficiency secured, and it is very much to be questioned whether with air-blown spray more steam is not lost in the air compressor than would blow the jet direct.

On the whole, it is concluded that Borneo oil should show a reduction in consumption of 40 per cent. as compared with coal, a reduction of 15 per cent. in bunker space, and of 50 per cent. for the same radius of action, while the stokehold staff may be cut in two.

Certain precautions are necessary in using oil. The crude oil contains a good deal of water and dirt. It ought to be filtered before it passes to the pipes. As regards water, even if as much as five of water to three of oil be passed into the furnace there will not be extinction. Most crude oils appear to have a specific gravity from ·9 to ·98, so the water does not gravitate out readily, and it seems desirable to heat the contents of the bunker so that the water may separate out, for oil expands more than water, and allows the water to sink more easily, not merely because of gravity, but also because of its greater mobility when warm.

PROSECUTION OF AN ELECTRIC LIGHT COMPANY.

AT the Greenwich Police Court on Friday, before Mr. G. G. Kennedy, the Blackheath and Greenwich District Electric Light Company, Limited, River Terrace, East Greenwich, were summoned by Mr. Joseph Owner, H.M. Inspector of Factories, alleging that a person named Arthur Robinson was killed on Oct. 22nd in consequence of the company having failed to securely fence certain dangerous machinery. There was a second summons for failing as occupiers to register the accident within a week of its occurrence, and a third for not fencing machinery dangerous to people employed on the premises. Mr. Gray was counsel for the Home Office, and Mr. Blanchard Wontner defended.

Mr. GRAY said that Robinson, who was a carpenter, was engaged in fitting a railing around the switchboard, and was taking out some bolts with one hand when the other came in contact with live metal, death resulting instantaneously. This was the second case which had been caused by the same switchboard. The case was brought under Section 5, Sub-section 3, of the Factory Act, 1878, as amended by Section 6, Sub-section 2, of the Act of 1891. He thought that all he had to do was to bring the case within that section.

Mr. WONTNER said that the switchboard was isolated on a raised gallery, and no one was allowed to be near it but the operators. The railing, which Robinson was fitting at the time of his death, was an additional precaution, and in touching the switchboard when he did he was acting disobediently. The company were anxious that everything proper should be done, and were now going to introduce a new design.

Mr. OWNER gave evidence as to the construction of the switchboard. He knew that the handles had been raised after the first fatal accident.

Prof. C. V. BOYES, a consulting electrical engineer, said that the switchboard could be protected, and it was not necessary to have exposed metal dotted all over its face.

Mr. JAMES SWINBURNE, Vice-President of the Institution of Electrical Engineers, said that it was a mistake to have dangerous bare parts on a switchboard. The precautions taken in this case were good extra precautions, but the switchboard should be safe, and the making of it so was a matter of no difficulty. Even a skilled person had moments of inadvertence. The switchboard was not particularly bad, as the fault was very general in switchboards. He should say that this board as an ordinary thing was safe, but it was dangerous to those working it, and exceedingly dangerous to those repairing it.

The summons was adjourned for a fortnight.

THE MUNICIPAL ELECTRICAL ENGINEER'S VIEW OF THE PARIS EXHIBITION.

BY E. K. SCOTT.

MR. V. A. H. M'COWEN has recently presented a report to the Gas and Electric Committee of the Belfast Corporation on the electrical exhibits at the Paris Exhibition. Read in conjunction with the report by Mr. S. E. Fedden, of Sheffield, it would almost appear as if the British manufacturer is going to have a pretty bad time. The italics in the paragraph below are, at any rate, significant of a good deal to home manufacturing firms. Mr. M'Cowen says:—

"As far as continuous-current dynamos are concerned, I believe there is very little to choose between Continental and British. There is no doubt that the commutation on the Continental slow-speed machines seen running was practically perfect; whether they can obtain such good results with large high speed sets is another question. As a rule, the design and finish of the machines compared favourably with the best British make. *Offers from Continental firms for this type of plant should be carefully considered.*

"In polyphase work Continental manufacturers are undoubtedly before us, and when we require plant of this type, either 'generating' or 'transforming,' for giving a supply in some of the outlying districts, as foreshadowed in my report of April 2nd, 1896, *it will certainly be desirable to obtain tenders from some of the firms mentioned.*"

Needless to say, the firms *mentioned* are mostly leading Continental manufacturers.

The desire of what may be called the "Patent Office electrician" to make something quite different to anyone else, whilst a good thing in some ways, created the curse of a "royalty mongering," which, whilst appearing to help forward, is really a bar to sound electrical engineering progress. It is this kind of thing, for example, which has been mainly responsible for the perpetuation of the copper type alternator, and the overloading of dynamo armatures with copper in order to stop sparking! Whilst some engineers and firms in this country have been pushing such like freak machines, the Continental and American engineers have given their energies and attention to the turning out of machines mechanically sound in design and construction, and generally speaking, they have not made the foolish error of mistaking drawing office improvements for patents.

It would, however, be unfair if municipal engineers were to forget that there are some English firms who have for years made the machines which have undoubtedly shown themselves the fittest to survive—that is the ordinary multipolar dynamo without embellishments, and the alternator with stationary armature and interior revolving poles having a coil on each pole. It does not appear to be generally known that all single-phase alternators made on the above lines are simply multiphase alternators having a portion only of the armature slots filled with copper wire, and that it is the easiest thing in the world to add more coils and so convert such machines into multiphase alternators. A 10-year-old Elwell-Parker machine has been altered by Johnson and Phillips into a very good two-phase synchronous motor, and the present two-phase alternators at the Clerkenwell station were originally supplied and worked for many years as single-phase machines. There is nothing mysterious about multiphase work, and it is to be hoped that when municipal engineers ask for tenders for multiphase plant they will not favour Continental firms unduly. As a matter of fact, if the "general conditions" contain the awkward clauses which home firms have usually to subscribe to, it will be practically impossible for foreign firms to fulfil the requirements; and, on the other hand, if the labour clauses are deleted or so modified that foreign firms may tender, home firms will then be able to quote lower prices, for the amount of a tender nowadays depends a great deal on the way the "general conditions" are worded.

It is obviously an injustice to home firms to issue a specification and conditions containing onerous clauses and then to accept the tender of a foreign firm, who may be at the time only represented in this country by agents.

As a case in point, the Plumstead Vestry recently placed a contract with the Westinghouse Company, the conditions being among the most onerous which have been issued within recent years, for besides the usual clauses there was a list of the rates of wages covering practically every variety of labour likely to be employed in a dynamo works, the conditions also calling for the posting up of rates of wages in the shops, &c. Now, as the new Westinghouse works at Manchester have not advanced much beyond the foundation stage, and the plant has to be delivered under penalty early this year, it is difficult to see how the machinery is to be made in this country, and yet, if the machinery or any part of it is imported, it will clearly be an injustice to home firms, who have every cause to protest. West Ham, again, is notorious for the importance which the local Jacks-in-office attach to labour clauses, and yet the West Ham installation reeks of foreign-made apparatus. If a British firm, *particularly if a local one*, tenders, they have to make allowance in

the estimate to cover any trouble that may be sprung on them on account of labour or other clauses ; for as they stand at present some of these clauses are practically impossible of fulfilment. Take the question of sub-contracting. How in the world is it possible for an electrical firm to make those who supply the steel, copper wire, instruments, &c., to keep certain hours of labour, exhibit the rates of wages in their workshops, and so on ? As a matter of fact, it is just possible the electrical manufacturer may not know where some of the apparatus he buys is really made.

Coming to engines, Mr. M'Cowen's report is more pleasant reading, for referring to the large slow-running engines which seem to have impressed so many visitors he says :—

"Although one is bound to admire the massive appearance of some of the large slow speed engines so much in evidence, the complications of valve gears, and the number of men apparently necessary, employed in connection with the running, impressed me with the simplicity and the small amount of attention required in operating our own plant ; and so far I have seen nothing which I would put before the high-speed engines in our own station for electric lighting or traction purposes."

As a matter of fact, the enclosed high-speed engines of Delauney Belleville with forced lubrication at 120 lbs. (against 12 lbs. in Belliss), and those by Emile Metz, showed that our neighbours have also recognised the great advantage of the short stroke engine, and if competition is to come at all, it will be in high-speed engines. British engine makers have nothing to fear from three deckers of the Borsig type or the other massive marine-type engines, because when the units become large enough our own marine type engine builders will be able to supply all engine power required.

With regard to the horizontal type, the Sulzer engines were beyond criticism, but they are so expensive that few are likely to come into this country. The American horizontal engine has certainly got a footing, because it is cheap, but when it becomes generally known that the American makers are not even thorough enough to put liners into the cylinders, there should be a strong reaction in favour of the home-made article.

ELECTRIC TRAMWAY ENTERPRISE.

[FROM A LEGAL CORRESPONDENT.]

WITHIN a few weeks the Parliamentary Committees at Westminster will be deeply engaged in the consideration of numerous Bills for the promotion of electric tramway systems throughout the country. Of more extended interest than the subterranean railways which are to be laid beneath London, the career of a Bill which seeks to establish an electric tramway is watched with considerable anxiety in every part of the kingdom. That anxiety is not lessened by ignorance of the case which the promoters may have to meet when their scheme is laid before a Parliamentary Committee. It is true that "a petition against a Bill" may sometimes disclose the general nature of the opposition ; but a mass of evidence is often brought forward, to which the promoters may attach but little importance, but which may have considerable weight with those who have power to declare the preamble proved or not proved.

Seeing that a Committee of the House of Commons is in reality a legal tribunal, one would have expected that some reliance would be placed upon precedent, that weight should be attached to the "recent decisions" of Committees upon similar Bills and Clauses, and that some attempt at uniformity of principle would be made through the medium and constant use of reports or synopses of former proceedings. An enterprising member of the Bar* has already published two volumes of such synopses. The continued publication of these reports may tempt the learned gentlemen who practice at the Parliamentary Bar and the Members of Committees to realise their merit and use them more freely.

Seeing that information with regard to the evidence which is likely to weigh with Members of Committees cannot be readily acquired—the shorthand notes of proceedings being costly and difficult to obtain—it may be useful to refer to one or two electric tramway Bills which have been promoted before and rejected by some of the Westminster Committees. It is anticipated that a consideration of the evidence which was tendered in these cases will furnish some idea of the matters which affect the mind of a Parliamentary tribunal.

In 1898 the Corporation of Hastings sought Parliamentary powers to lay down electric tramways on the trolley system within the borough. It was proposed to lay down two independent systems, which, with their branches, amounted in length to about 8 miles. A similar scheme had been rejected in a former year on the ground that it was proposed to run a line along the sea front. No such clause was inserted in the Bill of 1898, which was mainly designed to provide for an easy system of passenger communication between the centre and the higher parts of the town away from the sea. The streets were narrow in places—one street being only 18 feet wide in one part, while steep gradients—in one place 1 in 9—and sharp curves rendered it difficult, but not impossible, for an electric tramway to be laid down. The promoters were confident that all the difficulties above noted could be overcome. They urged that the decrease of carriage and char-a-banc traffic, which would naturally follow upon the erection of the tramways, would tend to diminish obstruction in the streets; that gradients of 1 in 9 or 10 had been overcome in other towns, *e.g.*, Sheffield, and that there was no curve of less than 66 feet radius. The scheme had met with the approval of a majority of the Corporation.

A petition signed by some 420 ratepayers was filed in opposition to the Bill. They represented a ratable value which was only about one-fortieth of the ratable value of the town. The main objections to the scheme were, in addition to narrow streets, steep gradients and sharp curves—(*a*) that the trams could not be made to pay unless they were run along the sea front; (*b*) that as the two main systems were not united the benefit to the town would be but small ; (*c*) that the beauty and attractiveness of the town would be marred by an electric tramway on the trolley system, and the rails would be a source of danger to the owners of carriages ; and (*d*) that the quiet and efficiency of the town as a health resort would be seriously impaired, and that visitors and invalids, who contributed so largely to the prosperity of the townspeople, would be frightened away.

The reasons enumerated under headings (*a*) and (*b*) *supra*, which must have influenced the Committee in some degree, are more or less common form in petitions against undertakings of this kind. We direct special attention to those mentioned under (*c*) and (*d*) which are not frequently resorted to. A number of eminent medical men were called to show that the existence of a noisy electric tramway in Hastings would have the effect of preventing doctors sending their patients there for rest or change. Eventually it was found that the preamble of the Bill was not proved. The general conclusion to be drawn from this case is that a Parliamentary Committee will take the very broadest view of the question which is submitted for their consideration. Here it was shown that Hastings was not in any sense of the term a *manufacturing* town ; that noise which in a busy northern municipality would not even attract the attention of residents, would have a serious effect upon those who visit Hastings in pursuit of health ; and would therefore directly injure hotel proprietors and lodging-house keepers who carry on the industry of the town. The wisdom and justice which guided the Committee in arriving at their decision must be acknowledged on all hands.

When the question whether electric tramways shall be introduced is at issue between the local authority and a private company, very different considerations arise. The *immediate* interests of residents in the affected district then become hidden behind the strivings of the local Bumbles and the enterprising promoters of some influential company. It is advisedly that we say "the *immediate* interests" of residents are lost to view. The local authorities, acting for themselves and their successors, must be presumed to consult the present or future welfare of the ratepayers by whom they are elected. That present welfare, so far as electric tramways are concerned, is sometimes neglected is all too clear; that the retention and exercise of a right of compulsory pur-

* See "Newbon's Reports of Private Bills."

chase as soon as that right can be exercised, is an unmixed blessing remains to be seen.

A favourable instance of a Bill being strangled by reason of a conflict between "company and local authority," was furnished by the South Staffordshire Tramways Bill in 1898. In that case the promoters (a wealthy electrical company) sought to amalgamate all the tramways which lie in and between the numerous boroughs which are scattered about in South Staffordshire, and to work them electrically. Dudley, Walsall, West Bromwich, and a number of other towns were to be included. The South Staffordshire Tramways Company had for some years carried on a tramway in a portion of the district, but was never a signal success; the promoters sought to obtain a 21 years' lease of their undertaking from this company. In order to ensure a certain fixity of tenure which would enable them to recover part of their capital expenditure, the promoters had asked for a clause which would prevent the various local authorities from exercising their right of compulsory purchase until a period of 35 years from the date of the Bill had elapsed. At the conclusion of that period the local authorities were to have the option of purchasing that portion of the promoters' undertaking which ran through their respective districts as "a going concern." As might be imagined, this somewhat drastic, but, having regard to the magnitude of the undertaking, not unreasonable, clause was strenuously opposed by nearly all of the ten local authorities through whose districts the proposed lines were to run. Said each of them: "The Tramways Act, 1870, Sec. 43, conferred upon us a right of purchase after 21 or after each succeeding period of 7 years. That right will soon fall in, and we must not now be deprived of it!" They called no witnesses in opposition to the Bill, nor, indeed, were they asked to call any witnesses, but merely filed petitions and employed learned counsel to cross-examine the promoters' witnesses.

The following arguments, supported by weighty evidence, were put forward on behalf of the promoters in favour of the postponement of the right of compulsory purchase at mere "old iron prices." Here was a large and densely populated district in which there were a number of boroughs which might well become merged in the course of time. The local authorities had never attempted to come to an agreement for working conjointly; their rights of emption from the existing company would all fall in at different periods so that unification would be rendered difficult; moreover, as the promoters already owned a number of light railways in the district, their collaboration must be sought if a united system, which would be an undoubted benefit to the neighbourhood, was demanded. The existing tramlines were not of uniform gauge, the promoters intended to make it uniform; the existing source of power was steam or horse traction; the promoters would make it all electrical. Without hearing any witnesses, or calling upon counsel on behalf of any of these local authorities, a Committee of the Upper House threw out the Bill—in so far as this 35-year clause was concerned! In the space at our disposal, we are unable to draw attention to the evidence in the above case at greater length. It is reasonably clear, however, that the point which influenced the minds of the Committee was the demand for a 35-year monopoly. The local authorities urged that they would be deprived of a valuable source of revenue; that profits which should be devoted to the interests of the ratepayers would be poured into the exchequer of a foreign company. Acting upon the best information and advice which they were able to obtain, the Committee threw out the Bill; but it is a serious question, when we come to consider the larger issues, whether they were right in doing so. It was pointed out by more than one witness that the Tramways Act of 1870 is out of date. The period of 21 years, which was fixed by Sec. 43 of the Act of 1870, was probably sufficient to enable the company to redeem a good part of the comparatively small outlay necessary to establish a horse tramway. The Act of 1870 was drafted, and became law, at a date when electric tramways were not dreamt of. Is it to be supposed that a company which incurs the expense of installing an electric tramway system can recoup in 21 years and sell their undertaking at the close of that period at old iron prices with any chance of pleasing the shareholders? It is submitted that the section under notice is obsolete, and that the period after which the power of compulsory purchase may be exercised should always be determined by the Committee. It is satisfactory to know that in considering applications under Sec. 11 of the Light Railways Act, 1896, the Light Railway Commissioners have taken a broader view of this difficult question. A tramway is but a light railway under another name, and by seeking powers under this up-to-date statute the undertakers have upon several occasions obtained a 35 years', and in one instance a 50 years', monopoly of the tramway service.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

365. "An improved electric car trolley head." T. J. Littler. Dated January 7th.

367. "Improvements in multiple wall connections for electric lighting, heating, and the like." A. P. Lundberg and G. C. Lundberg. Dated January 7th. (Complete.)

393. "Improvements in electrolysis and apparatus therefor." P. A. Newton. (The National Electrolytic Company, United States.) Dated January 7th (Complete.)

409. "Improvements in apparatus for wireless telegraphy." G. Marconi and Marconi's Wireless Telegraph Company, Limited. Dated January 7th.

410. "Improvements in apparatus for wireless telegraphy." G. Marconi and Marconi's Wireless Telegraph Company, Limited. Dated January 7th.

411. "Improvements in apparatus for wireless telegraphy." G. Marconi and Marconi's Wireless Telegraph Company, Limited. Dated January 7th.

441. "Improvements in the electrolytic bleaching of cotton and other textile materials, and in apparatus therefor." O. Lauckner. (A. Vogelsang, Germany.) Dated January 8th.

459. "Improvements relating to electrical organs." E. G. Pulford. Dated January 8th.

467. "Improvements in attachments for telephones." D. Laing and G. M. Ferry. Dated January 8th. (Complete.)

469. "Improvements in or connected with electrical storage batteries or accumulators." O. Behrend. Dated January 8th.

471. "Improvements in electric motors." The British Thomson-Houston Company, Limited. (E. D. Priest, United States). Dated January 8th. (Complete.)

484. "Improvements relating to secondary electric batteries." H. H. Lake. (Globe Electric Company, United States.) Dated January 8th. (Complete.)

486. "Improvements relating to electric switches." H. H. Lake. (Globe Manufacturing Company, United States.) Dated January 8th. (Complete.)

492. "Improvements relating to apparatus for measuring the power and the phase-difference in three-phase electric systems." R. Arno. (Date applied for under Patents, &c., Act 1883, Sec. 103, June 8th, 1900, being date of application in Italy.) Dated January 8th.

501. "Improvements in or connected with electro-motors." F. M. Lewis. Dated January 8th.

503. "Improvements in electric driving mechanism." A. de Castro and H. W. Schlomann. Dated January 8th. (Complete.)

507. "Improvements in electric switches." W. Ely. Dated January 8th. (Complete.)

543. "Current collectors and safety devices applicable to electric railways and tramways." J. Parsons and P. F. Otto. Dated January 9th.

560. "A device for drawing the trolley arm of an electric locomotive or other vehicle propelled by electricity to a safe position should the trolley become disconnected with the supply wire or bar." H. S. Jacques. Dated January 9th.

569. "Improvements in electrical regulating, measuring, and indicating apparatus." A. Campbell. Dated January 9th.

585. "Improvements in and relating to electric switches and the like." F. H. Headley. Dated January 9th.

594. "Improvements in and connected with means and apparatus for the production of light by electricity." J. T. Armstrong and A. Orling. Dated January 9th.

595. "Improvements in and connected with means and apparatus for the production of light and certain other rays by electricity." J. T. Armstrong and A. Orling. Dated January 9th.

596. "Improvements in and connected with means and apparatus for the production of light by electricity." J. T. Armstrong and A. Orling. Dated January 9th.

612. "Improvements in the manufacture of sulphate of ammonia from furnace gases, and the like by electrolysis." R. Kennedy. Dated January 10th.

624. "Improvements in or relating to electric storage batteries." M. Sutherland and E. Marcuson. Dated January 10th.

681. "Improvements in electric mono-rail railways and vehicles, therefor applicable also for other traction." J. M. Hewitt, W. G. Rhodes, and J. M. Newton. Dated January 10th.

688. "Improvements in the construction of telephone cables." F. Tremain. Dated January 10th. (Complete.)

690. "Improvements in electric controllers." J. Y. Johnson. (The Electric Controller and Supply Company, United States.) Dated January 10th.

691. "Improvements in resistance coils." J. Y. Johnson. (The Electric Controller and Supply Company, United States.) Dated January 10th.

692. "Improvements in arc rupturing devices for brush holders and the like." J. Y. Johnson. (The Electric Controller and Supply Company, United States.) Dated January 10th.

700. "Improvements in the manufacture of wire strips and the like by electro-deposition, and in apparatus therefor." R. D. Sanders. Dated January 10th.

702. "Improved system of electric traction." C. M. J. (dit Claudius) Limb. Dated January 10th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 5th, 1900, being date of application in France.)

706. "An automatic indicator and recorder of, and signal aboard, approaching or passing cars or trains, and of the routes taken likewise a herald thereof to passengers' waiting points as all such independent of fog, &c., also applicable to electric bell annunciators for minimising wires, movements, &c., and to other purposes." E. L. Benjamin. Dated January 10th.

740. "Improvements in and connected with call lines in telephone exchanges." H. OPPENHEIMER. (Actien Gesellschaft Mix and Genest, Germany.) Dated January 11th.

750. "Improvements relating to filaments for incandescent electric lamps." E. SANDER. Dated January 11th.

776. "Improvements in or relating to electrically operated ploughs." C. MEISSNER. Dated January 11th. (Complete.)

802. "The application of an electrical apparatus for working the speed counter or speed recorder on steam, gas, oil, or other engine or any machine having moving parts." W. RENNISON. Dated January 12th.

831. "Improvements in laying street underground electric conductors." W. B. ISWORTH. Dated January 12th.

833. "Improvements in current collectors for electric railways." F. TAYLOR. Dated January 12th.

840. "Improvements in electric safety fuses." SIEMENS BROS. & COMPANY, LIMITED. (Siemens & Halske Actiengesellschaft, Germany.) Dated January 2th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

pies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

3,412. "Improvements in electrical apparatus for recording the time of working of machines and for like purposes." J. H. Barker. Dated February 15th, 1899. The apparatus shown is for recording the length of time that generators at a station have been at work, and keeping a log of the details of working, such as the current supplied; but the apparatus is applicable also for other machines, A drum driven by clockwork is covered with paper, ruled longitudinally for time and transversely for the different machines, &c. At one end of the casing, beneath a glass front, a series of pens are placed which, when any generator is at work, are drawn into contact with the paper by shunt-circuited electro-magnets. Beyond this part of the apparatus, a glass plate is provided with a long slit through which the attendant can make any notes he desires. The drum may be moved continuously or intermittently, and details of construction may be somewhat varied. 3 claims.

3,469. "Improved primary battery." L. Encausse and L. Encausse. Dated February 16th, 1899. Relates to a two-fluid battery in which one of the elements is composed of three metals, preferably a copper vessel enclosing thin sheets of lead and thin sheets of zinc, the sheets of lead being shorter than the sheets of zinc, so that only the copper and zinc are clamped together by the terminal. The other electrode consists of carbon plates enclosed in a porous vessel, the surface of which is coated to a greater or less extent with paraffin, according to the quantity of current desired to be generated. The whole may be enclosed in a casing of india-rubber. The provisional specification describes the three-metal element as consisting of a brass vessel with a bottom of copper and another metal, and with thin sheets of zinc fastened to the wall of the vessel. 1 claim.

3,594. "Improvements in arc lamps." H. Baggett. Dated February 17th, 1899. Relates to arc lamps. The carbon holders are hung from opposite sides of a double-grooved pulley, the upper holder on the left being heavier so that the carbons tend to move together. The pulley is provided with a lateral flange and a covering ring, to hold loosely two metal segments, which are connected together by a flat spring. A cam is pivoted on the upper segment, and bears against a pinion the lower one to press the segments apart, so that they grip and turn the pulley, when the outer part of the cam is raised by a link, a regulating lever, and the core of a series solenoid, the arc being thus struck. Feeding occurs on reverse movements of the parts, such movement of the segments being limited by a stationary screw or adjustable stop. The regulating lever may be acted on reversely by the core of a shunt solenoid. The pulley may be further controlled during feeding by a small india-rubber brake block, supported on a horizontal shaft above the pulley so that it can rock to a limited extent with the movement of the pulley; when the arc is struck this brake block is raised from the pulley by an adjustable slider against which the regulating lever then bears. The form of the cam may be modified, and its outer end may carry a projection within a hole in the upper segment, to pull this downward when necessary. The segments may be pressed lightly apart by an interposing spring. 3 claims.

3,597. "Improvements in or relating to electrical railway switching and signalling apparatus." A. J. Boult. (The Continental Hall Signal Company.) Dated February 17th, 1899. Relates to electrical mechanism for operating and controlling railway points and signals, and is described as employing in conjunction with derailing switches where a single track crosses a double track. The signals indicate whether the switches are closed or open, and are operated as described in Specification No. 3,176, A.D. 1899, the switches being normally open and the signals at "danger." The operating levers which control the motor circuits of the various switches and signals are interlocked by a transverse slide, furnished with dogs, which engage in notches in the slides. 16 claims.

3,648. "Improvements in or relating to the electrolysis of salts in solution and apparatus therefor." A. J. C. Chalandre, L. J. B. A. Colas, and C. J. Gerard. Dated February 18th, 1899. Relates to the suppression of secondary reactions when electrolysing an alkaline chloride, or other aqueous electrolyte, and consists in causing the evolved hydrogen and chlorine to combine, and in returning the so-formed hydrochloric acid to the anode compartment. Any form of electrolytic apparatus is provided with a collector for the hydrogen given off from the cathode compartment. The hydrogen passes by a tube to a burner enclosed by a glass cylinder, and closed at both ends by plates connected together by bars, the whole being preferably surrounded by a close wire netting. The chlorine evolved in the anode compartment passes by tubes to the burner chamber. The hydrochloric acid formed passes by a tube to the circulation tube of the anode compartment, and is forced by a pump to the anode compartment for the object stated. Only a part of the chlorine is thus utilised, the rest being led way to a holder. 4 claims.

3,746. "An improved electric switch." W. J. Murphy. Dated February 20th, 1899. Switches and cut-outs for use in systems of lighting in which a group of lights may be thrown out of circuit from the main switch without interfering with the others, or may be thrown out independently of the main switch. Means may be provided for preventing pampering with the switch. In one form of the subsidiary switch to the base are fixed the contacts, and in a recess is an electro-magnet. Pivoted on a block is a tumbler consisting of a frame connected by a brass or like non-magnetic piece, and having projecting arms connected by a pin. Also pivoted on the block is a lever, preferably formed of sheet iron, so as to complete the circuit when pressed down to close the switch. To it and the base is secured a spring. So long as a current is flowing through the circuit the switch is held closed, but on breaking it, as by flicking the main switch, the lever springs up under the action of the spring, and lifts the lever by striking the cross pin. In a modified form, in which the switch can only be opened from the main switch, the lever is operated by an S-shaped cam mounted on a spindle. The spindle is rotated by the handle which carries pawls engaging with recesses in a disc. The spindle can only take up two positions, being controlled by a cam working between springs. 6 claims.

3,784. "Improvements in electric safety appliances." T. H. Badger and W. J. Plews. Dated February 20th, 1899. Relates to means for cutting out a low-tension branch circuit in the event of connection being made with the high-tension supply circuit. A double pole switch has a catch adapted to engage a trip lever normally held fast by the armature of an electro-magnet. The magnet has two coils, both connected to earth, and the other ends connected to adjustable contacts forming spark gaps with the terminals of the low-tension circuits. Should a high tension connection be made with either of the conductors, sparking will take place at one or both of the gaps, and the electro-magnet will be energised. The trip lever is thus released, and springs throw off the switch. Pushes are provided for short circuiting the gaps for testing the apparatus and the insulation. 3 claims.

3,786. "Improvements in or connected with electric incandescent lamps." J. G. Lorrain. (H. A. Macdonald.) Dated February 20th, 1899. A straight rod or tube of magnesia, kaolin, columbin, porcelain, or like refractory material is kept incandescent by passage of current after it has been rendered conductive by electric heating. Several methods of heating are specified. A refractory tube may be supported at its ends by an insulator and a cap and conductor, and be heated by an enclosed platinum or other wire, which is stretched between a spring and a button; on starting, current passes through the spring, wire button, and a two-metal strip until the tube becomes hot enough to convey current from the button to the support, the strip then also becoming hot and bending outward, so that the current can only pass through the wire and tube in series between the conductors. The wire then serves as a steadying resistance. The strip may be replaced by an electro-magnetic cut-out. In another arrangement a refractory rod is coated with a conductor such as copper, carbon, or carbon mixed with refractory material, which may be cut away at the middle, leaving a narrow connecting strip, or a thin connecting ring, and the rod may be provided with thickened or cast ends to facilitate connection; when current is supplied, the coating becomes hot and burns off or an arc is produced at the cut away part, and the rod is thus heated and left exposed to emit light. The rod may be thickened where the narrow strip is left, to resist the action of the arc. Such coated rods can only be used once, and need last only a few hours; holding springs are adapted to permit insertion of a new rod each time of lighting. In another arrangement, a refractory tube is provided with perforted end caps which carry two thin carbon rods within the tube, in contact at the middle of the tube, where an arc is formed until the carbons have burnt too short to maintain it, this also can be used only once. In a modification, which may be started as often as desired, the refractory tube is vertical, and the lower carbon is fixed, but the upper carbon passes through a clutch-plate carried by a tubular iron core below a solenoid; the ends of the refractory tube and the carbons are connected in parallel, the solenoid being in series with them, so that it first strikes an arc, and afterwards holds up the upper carbon. In another arrangement, a refractory rod is supported horizontally below the meeting edges of two inclined carbon plates, which are attached to the iron cores of solenoids, and are thus separated to form a heating arc; stoneware stops may be provided to prevent the carbons from falling on the rod. The carbons may be controlled otherwise, and means may be used to project the arc against the rod. 20 claims.

3,868. "Coin-controlled and registering telephone apparatus." R. D. Cranston and S. M. Williams. Dated February 21st, 1899. The contacts over which the automatic switches hook plays when the receiver is taken on and off are made to follow it after removal of the receiver so as to revert to the "ringing up" connection, the switch hook being meanwhile locked. Prepayment is then necessary to allow speaking. The apparatus is as follows:—A slide connects the pivoted block which bears the contacts, with a bell crank (to which a prop for the switch hook is jointed), by means of two pins, the former engaging a slot in the block and the latter resting on the joint of the prop. Normally the bell crank, which is subject to a lifting spring, is held down by a detent obstructing its lower arm, but after "ringing up" and removal of the receiver a current sent from the central station through an electro-magnet makes a hammer extending from the rocking armature knock away the detent by striking an intermediate finger. The slide is consequently lifted to set the contacts, the prop then preventing the switch from being put down again. An indicator attached to the bell crank now instructs the user to push down a rod (normally after prepayment has released it), which by means of an arm thrusts the bell crank down again till it knocks away a spring prop from under the slide, so allowing the latter to follow and set the contact again. By means of a pair of pawls engaging a pinion the push rod drives a disc having peripheral pockets for the coins inserted at a slot and required to lift a pawl. If there is to be no prepayment the pawl is held clear by a bolt. The coins eventually drop out of the disc into a drawer which can only be drawn out after breaking a paper seal. A pin at the bottom of the rod pricks a paper band fed on by a ratchet lever which is connected to the rod by a link, and unless the rod is pushed down far enough to do this the bell crank will not be caught by its detent. 5 claims.

3,999. "Improvements in electric traction for tramcars and the like with accumulators." J. Milnes. Dated February 23rd, 1899. Accumulators or secondary batteries on tramcars are charged direct from underground conductors through boxes placed at intervals along the line. The conductor passes through the box which is provided with a sliding lid and a short flexible lead is attached to the collar on a bared part of the conductor. This lead may be carried on the car and provided with a channel-shaped piece to fit over the conductor, and a hinged or other lid may be provided on the box, or the lid may be provided on the box, or the lid may be provided with an insulated conducting piece and raised or lowered by screws or otherwise to complete the circuit. 7 claims.

4,078. "A new or improved machine tool particularly applicable for refacing or turning commutators of electric generators and the like." D. Honeywood. Dated February 24th, 1899. Relates to a portable machine tool particularly applicable for turning, grinding, or truing up the faces of the commutators of electric machines. The machine comprises the rotating tool bar, bearings, sockets, slide rests, and devices for securing the slide rests to the barrel which, carrying the screw, is fixed by the adjustable clamps to the dynamo or other article requiring treatment. The overhanging end of the feeding screw is supported upon a leg. Motion is transmitted to the cutting or abrading tool from the pulley through which the tool-holder passes. The motion may be derived from an electro-motor suitably mounted on the machine or by the dynamo itself. If desired, the spindle and bearings may be dispensed with, and an ordinary turning-tool substituted. 3 claims.

4,088. "An improved lampholder for incandescent electric lamps." W. Lynes. Dated February 24th, 1899. Relates to holders for incandescent lamps. A cylindrical insulator for use in an ordinary bayonet-joint holder is made with two longitudinal holes to receive plunger carriers. Each hole may be partly round and partly angular or oval to fit the parts of the carrier, but the angular portion of the hole is made so deep that the carrier is at some distance below the back surface of the insulator. The carrier is held in place by a screw inserted in a transverse hole in the insulator, and the supply wire is secured by another screw inserted from the opposite side into a recess in the carrier. 3 claims.

4,095. "Improvements in electrical switches." Veritys, Ltd., and L. J. Steele. Dated February 23rd, 1899. To prevent arcing the moving contacts are fitted on a moving disc or screen working between the fixed contacts. The contacts are mounted on a rotary disc and the fixed contacts are arranged in pairs, one member of each rubbing the contact above the plate, and the other the lower part of the contact. The operating handle is loosely connected with the disc, and a spring is fitted to give the quick break. 4 claims.

4,121. "Improvements in miners' safety lamps and in means for electrically igniting the same." W. Best. Dated February 24th, 1899. In lamps which may be ignited electrically, the light is improved by the use of a burner cone and a specially shaped glass chimney, the burner cone also forming a small chamber to which is confined any explosion resulting from the entrance of inflammable gas. A piece of the metallic wick tube is bent over the edge of the earthenware or non-conducting burner head, at the opposite side of which is arranged the insulated and spring-connected conductor. The air supply, entering through openings, passes beneath the baffle and through the gauzes to the flame; and the products of combustion, after traversing that portion of the gauze cylinder which is above the flange of the glass chimney, escape through the hollow swivel and the protected openings of the cap. 7 claims.

4,137. "A new or improved galvanic bandage." P. L. Schmidt. Dated February 24th, 1899. The bandage consists of a strip of zinc and a carbon-manganese plate separated by a suitable exciting medium such as is used in dry cells. On the underside of the bandage is a strip of india-rubber which is connected with the zinc strip by metallic studs and with the carbon-manganese plate by similar studs, these studs forming the electrodes. 2 claims.